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ABSTRACT

This document contains the text of 37 papers presented at the international forum and conference on information Technology for Training and Education (ITTE). The conference focused attention on the contribution that information technology can make to training, retraining and education. In particular, the forum concentrated on the following: (1) information technology and specialist training; (2) technical training in postsecondary education; (3) perspectives on large scale implementations of information technology for training and education; (4) information technology and industrial training; and (5) information technology and the future. Each paper provides a distinct view of some aspect of information technology and training and/or education. These views range from using information technology to simulate dangerous conditions encountered while learning how to operate a power station, to using information technologies to train large numbers of staff in a variety of situations, to using information technology to create awareness about itself so that a large organization can move to policy development and large scale adoption of the technology. Most of the papers include their own reference list and abstract. International viewpoints were brought to the conference by speakers from Australia, Canada, Hong Kong, Japan, Portugal, Singapore, the United Kingdom, and the United States. (DB)

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Conference Proceedings

4–8 February 1991

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FOREWORD

ITTE '91 is an international forum and conference hosted by the Computer Assisted Learning (CAL) Unit and Continuing Professional Education of The University of Queensland from 4th to 8th February, 1991. It focuses attention on the contribution that information technology can make to training, retraining and education in the 1990's. In particular, the forum will concentrate on the following:

- Information technology and specialist training
- Technical training in post secondary situations
- Perspectives on large scale implementations of information technology for training and education
- Information technology and industrial training
- Information technology and the future.

This publication contains all papers presented at the conference with the exception of the Keynote Addresses. These are contained in a separate publication, 'ITTE'91 Keynote Addresses'. We have arranged for both publications to be available prior to the conference so that you can participate in the forum.

Forewords often set up a framework into which the published papers fall, and this sometimes makes for easier reading. However it is not easy to put a framework over such a diversity of perspectives as provided by the speakers at this conference. Each paper provides a distinct view of some apsect of information technology and either training and/or education. These views range from using information technology to simulate dangerous conditions encountered while learning how to operate a power station, to using information technologies to train large numbers of staff in a variety of situations, to using information technology to create awareness about itself so that a large organisation can move to policy development and large scale adoption of the technology.

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CAI UTILIZATION IN LANGUAGE TRAINING - DEVELOPMENT OF JAPANESE LANGUAGE *CAI* COURSEWARE

by

Tomoko Aeba

ABSTRACT

Recently, the demand for Japanese Language courses by foreigners has been increasing tremendously. The ratio of qualified Japanese language teachers to students has become critical outside Japan, especially where close interaction between teachers and students is indispensable in language training.

From the early stage, Japan-Singapore Institute of Software Technology (JSIST) emphasized the importance of implementation of CAI (Computer Assisted Instruction) system in its courses and has engaged in CAI Projects. Under this Project, Japanese Language coursewares have been actively developed since the subject was introduced in 1988.

In this paper, the role of CAI utilization in Language Teaching will be analyzed and the type of CAI courseware to attract students' interest will be discussed. For language courseware development, JSIST is using a multi-media CAI system, PC-SCAI, which can input and output Graphics, Image, Text and Voice. In addition, we are making simulation courseware using an animation software (GENKI).

Under PC-SCAI, we can introduce Japanese writing using free-hand technique and students can understand characters following the strokes. Using clear images, photographs and voice, students are able to learn the language through the natural processes. Students could now recognize the meaning of the word from the image, as well as familiarise with Japanese pronunciation.

In conventional CAI systems, still pictures are often used. However, we are making courseware using animation software, which can show conversational situations for simulation learning. Using a user-friendly authoring system will allow amendments, improvements and updates to be easily made.

CAI UTILIZATION IN LANGUAGE TRAINING - DEVELOPMENT OF JAPANESE LANGUAGE *CAI* COURSEWARE

by

Tomoko Aeba

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1. Background

Recently, the demand for Japanese language courses by foreigners has as been increasing tremendously (see Appendix 1). The ratio of qualified Japanese language teachers to students has become critical outside Japan, especially in the area where close interaction between teachers and students is indispensable for language training.

As the Japanese high-tech industries grow and expand their operations, the demand for more specified Japanese courses in science and technology fields increases. Science and technical institutions implementing Japanese language in their curriculum, face the common problem of being unable to recruit sufficient qualified Japanese teaching staff.

The Japan-Singapore Institute of Software Technology (JSIST) was established in 1980 under the cooperation of the Japanese government and Singapore government. The aim of the Institute is to prepare trainees for careers in computer-based data processing areas; either as application programmers or as systems analysts. In 1988, Japanese language was introduced into the curriculum of the two year full time Diploma in Programming and Systems Analysis course.

Right from the early stages, the Institute has emphasized and promoted the use of CAI (Computer Aided Instruction) as a teaching aid in its courses. Of late, the Institute is also engaged in CAI projects under the cooperation with the Japanese government. The cooperation consisted of:

1. lectures given by short-term Japanese experts on CAI (see Appendix 2),
2. attending CAI seminars,
3. sending staff to Japan for CAI training.

With the CAI project cooperation, the concepts on effective development of CAI courseware and design methods for effective teaching are addressed. Usage areas of CAI in Japan includes the majority of educational institution and a large percentage of industries, in the areas of Systems Analysis, Software Development, maintenance of copying and facsimile machines, so on. Trends and developments of CAI authoring tools are moving into the area of multi-media, user-friendly, menu-driven authoring tools, with minimum or no programming required. CAI with AI functions (ICAI) allows easier programming of the courseware and enables the instructor to estimate the understanding level of the students much quicker.

Under this CAI Project, Japanese language courseware has seen active development since this subject was introduced. The unique curriculum combination of computer subjects and Japanese language presented a conducive environment for development of CAI Japanese language courseware.

2. Development Concept of Japanese Language Courseware

2.1 Japanese Language Training in JSIST

Japanese language was introduced into the Diploma in Programming and System Analysis course in the 1988 as a compulsory subject. One of its task is to give students the opportunity to learn communication skills in Japanese. With the globalisation of Japanese multi-national companies, opportunities for communicating in Japanese with Japanese colleagues or counterparts or being asked to gather information on technological update in Japan, increases.

The Japanese language training in our Institute has 3 main setbacks. They are as follows:

1. critical ratio of Japanese teachers to students in a classroom (1:150 for lecturer and 1:35 for Language Lab.)

2. difficulty encounter by teachers in monitoring the progress of individual students, moreover the students are facing difficulties in oral exercises.

3. when students review the lessons, the absence of a consultative person or instructor, presents difficulty in understanding the lesson hence ineffective usage of self-study time.

One of the solutions to the above-mentioned problems is to increase the ratio of Japanese language teachers to students. This solution is not always realizable due to many factors. One of the realizable alternatives with many benefits attached is CAI.

2.2. Advantages of CAI Utilization

The advantages of using CAI to assist Japanese language teaching are as follows :

1. A student is able to learn under an interrogative atmosphere at his own pace with the absence of instructors.

2. CAI system can stimulate students who are not aggressive enough to ask questions or express opinions in the classroom.
3. With the On-line score, the student is able to monitor his own level of the understanding.

4. Teachers can get a quick overview of the class understanding level of the lesson. This enables teachers to prepare lectures better and amend CAI courseware accordingly.

5. CAI also conveniently allows teachers to monitor and tabulate the individual performance of students.

2.3. Process of CAI Courseware Development

Chronological process for CAI courseware development is as follows :

1. defining teaching objectives
2. breaking down the objectives into elements (tasks)
3. connecting elements and making network
4. detailed design (frame design)
5. step design (courseware design)
6. courseware making
7. review
8. courseware amendments

For steps 2 and 3 i.e. redefining the teaching objectives into various task and interconnecting these task or elements so as to derive the network, is all done with the ISM (Interpretive Structural Modeling) Conceptual Charts softwared. (Concept of ISM conceptual charts by Dr.T.Sato)

This process represents teacher-student model cycle shown in Figure 1.

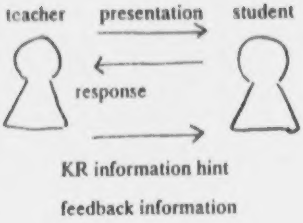
teacher
presentation
student
response
KR information hint
feedback information

Figure 1: Teacher student model

Figure 1 represents the cyclic process involved in CAI courseware designing.

On completion of a particular courseware students' participation is encouraged in the evaluation of;

1. the students achievement,
2. course implementation,
3. diagnosis of the students achievement, and
4. analysis of the performance data.

Once this evaluation is completed, decisions to amend the courseware can then be decided thus the processes repeat itself.

2.4. Contents of the Courseware

The courseware types developed are divided into 3 groups;

1. tutorial type
2. drill type
3. simulation type

2.4.1. Tutorial-type Courseware

Under the tutorial type, 10 coursewares totaling 663 frames have been developed based on a multi-media system in accordance with the textbook used in the classroom. The main purpose is to provide slow students opportunities to revise the lesson contents and familiarize themselves with the pronunciations at their own pace. Multimedia CAI systems, PC-SCAI*, provides clean and colorful images with sounds recorded by Japanese language teachers to further enhance the natural learning process.

Ample pictures and images as used to attract the students' interest and motivate them to learn the language. After each session on grammatical points, questions or revision on the particular section are given and simple encouragement such as " Good! ", " Well done! ", " Do you want to try again? " or " Try harder " are shown in accordance to students answers. The results of the students are not recorded in the system, but teachers can find out how often the courseware is used.

* PC-SCAI is CAI Multi-media system developed by NEC Corporation.
The configuration of the system is shown at Figure 2.

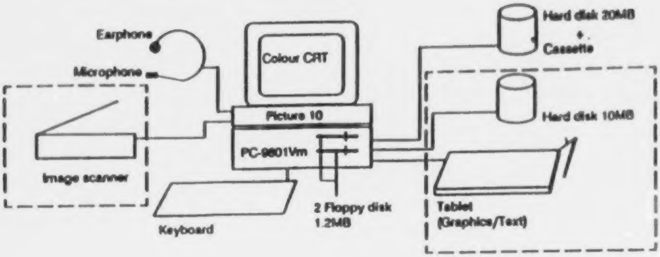
Earphone
Microphone
Image scanner
Colour CRT
Picture 10
PC-9801Vm
Keyboard
2 Floppy disk
1.2MB
Hard disk 20MB
+
Cassette
Hard disk 10MB
Tablet
(Graphics/Text)

Figure 2

2.4.2. Drill-type Courseware

Another type of courseware developed is the drills. They are mainly targeted at giving the students practice and exercise. Five drill-type coursewares consisting of 402 frames have been developed. The purpose has been primarily to prepare students for the " Japanese Proficiency Test Level IV " conducted by the Japanese government. The courseware contains exercises on grammar (mainly verbs, particles, verb forms and conjunctions), vocabulary, omprehension and listening.

Students can refer to their real-time score with the On-Line scoring function. The courseware is developed under PC-SCAI with BASIC language programme used for keeping the on-line score.

Development of the 2 types of coursewares discussed, started in 1988 and up-to-date, 15 coursewares consisting upto 1065 frames have been developed. It takes about 15-30 minutes to run through one courseware and it takes about 40-50 man hours to create a complete courseware.

2.4.3 Simulation-type Courseware

Besides the tutorial-type and the drill-type courseware, presently we are now developing a simulation-type courseware. The traditional language training is based on grammatical exercises and the CAI systems can cover certain levels of it.

However, as the need to communicate in Japanese in daily life increases, the language training emphasis shift towards the need for conversation skills based on actual situations. For this purpose, simulation-type courseware is extremely useful as it allows the students to chart the course of conversation and develop these skills by himself.

One example of completed courseware is to show an animation of a situation describing the conversation and students are then led to perform the conversation practice following the animated scenes. The conversation has a fixed sequential process to complete. Presently, we are now designing a courseware in which the students have options to choose the next animated scene from a set of scenes. Students have in their hands, the ability to chart their own conversation according to their interest.

For this courseware development, the Genki-Animation Software• is used with PROPI•. The problem of this courseware development is that it takes more time and requires more skill in designing the graphic pictures. To overcome this setback, a library of various pictures are initially created and stored. These library parts are retrieved as and when needed.

- Genki-Animation Software is developed by Lecht Science Inc.
- PROPI Authoring System is licenced product of Western Washington University and ASYS Computer Systems.

3. What is Unique?

Under PC-SCAI, we can also introduce Japanese writing by free-hand and students can understand and reproduce the characters by following the strokes. Using concise images, photographs and voice, students are also able to learn the language through the natural full immersion process; for example they have the opportunity to learn the meaning of the word from the image not via English translation and familiarize themselves with the pronunciation from repeated voice messages recorded by Japanese instructors.

In the drill exercises courseware, the On-Line scoring function is made possible by linking the courseware to BASIC, where the scoring function is done in BASIC. This allows each individual student to monitor their progress. In conventional CAI system, still pictures are often used, however effort is being made to develop coursewares using animation type of softwares. This is extremely effective when introducing forms of verbs, deplicting conversational situations, and simulating students' learning.

Japanese courseware is primarily designed for students' self-study after classes. By collecting feedback from students after using the courseware and based on the students feedback, (see Appendix 3) the courseware development emphasis has shifted from tutorial type to drill type and finally to simulation type.

A minor reason why the change from tutorial type to simulation type courseware, is due to the limited number of PC-SCAI systems avilable (10 sets for 150 students). To overcome this minor setback, courseware should be made with authoring tools which run on IBM compatible machines. Since IBM machines do not support Japanese characters, Genki animation software was fed into the IBM-PC compatibles. Under the Genki environment, Japanese characters created under non-IBM machines is transported and run under IBM machines. This is one of the solutions used to expand the Japanese courseware utility.

4. Summary of Courseware Design

One of the keynotes in designing the required courseware is the ease at which the teacher can amend, improve or update the courseware easily soon after attaining feedback from the students.

It is hardly productive as well as extremely time consuming for language teachers to develop CAI courseware using programming languages like BASIC or C. And if the course is designed by programmers they may create the courseware different from the teaching aim or target.

The completed courseware system should be user-friendly, especially for the language teaching environment. Hence it is most ideal if the language teachers themselves create the required coursewares.

5. What is NEXT?

The pressing present priorities are;

1. Ensure that equal opportunities exists for all students who need to use the system when they want to practice.
2. For effective usage of resources, lessons need to be categorize into those which require the multimedia system for maximum learning impact of the courseware and those which could be covered using the IBM compatible CAI software.
3. To create an atmosphere where the students are completely at ease with ;
    - i) "talking" to a computer
    - ii) cultivate the habit where difficulties encountered in the language are first tested out with the courseware.

Inorder to ensure that various common forms of difficulties encountered by students learning the Japanese language are addressed, plans to develop the further coursewares are as follows.

1. Grammar

i) Tutorial type courseware is to be developed for a beginner. This courseware is approximately 60 hours.

ii) Simulation cum drill type coursewares for the elementary stage students. This will be between 60 and 150 hours duration. The purpose is to assist the students to gain confidence and attain the skill and tact to hold a conversation in Japanese.

2. Writing

i) Tutorial type courseware is to be developed with emphasis on concept and stroke order of the written characters for students who lack exposure to Chinese type characters such as Kanji.

ii) Simulation cum drill type courseware will be targeted at students with Chinese background. This is mainly aimed at enhancing the capability of the students in reading Kanji.

Further future goals would be in the area where voice synthisers could be used to correct the students pronunciation. Digitizing tablets together with light pens could be incorporated into CAI to teach and correct the students in writing Kanji.

As the full potential of ICAI (Intelligent CAI System), is not fully taken advantage of, it will definitely be most important to base studies and research in that area as it is believed that ICAI can offer more flexible learning facility to students based on their study history and their understanding levels.

JSIST is a joint member of the ICAI project under the cooperation of Singapore government and Japanese government and is engaged in the development of new authoring tools. Along this line , we are also developing Japanese language courseware on the ICAI System.

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1. Educational Information Engineering. Dr. Takahiro Sato. 1987 (in Japanese). NEC Cultural Centre.

2. The ISM Teaching Objective Structure Chart Analysis. Dr Takahiro Sato. 1988. pp 8-9.

3. On the Architechure of Intelligent Tutoring Systems and its Realization. Toshio Okamoto. Tokyo Gakugei University.

Appendix 1

1989年試験結果概要

Results of the 1989 Japanese Language Proficiency Test

1989年日本語能力試験は、海外では21の国・地域、46都市で国際交流基金と各地の試験実施団体との共催により、また、日本国内では東京・大阪・福岡の3都市で財団法人日本国際教育協会により、12月10日、一斉に実施されました。

The 1989 Japanese Language Proficiency Test was administered on December 10th in 46 cities in 21 countries abroad under the co-sponsorship of the Japan Foundation and local host institutions, and in three cities in Japan (Tokyo, Osaka and Fukuoka) by Association of International Education, Japan.

1989年日本語能力試験の結果は次の通りです。

The results of the 1989 Japanese Language Proficiency Test are as follows:

(1) 国内・国外別受験者数等 Japan/Overseas Examinees and Certification Results

		応募者(人) A	受験者(人) B	認定者(人) C	認定率(%) D
国内 Japan	1級 Level 1	12,143	10,714	3,468	32.4
	2級 Level 2	2,390	1,902	1,034	54.4
	3級 Level 3	1,555	1,215	956	78.7
	4級 Level 4	463	352	307	87.2
	計 Subtotal	16,551	14,183	5,765	40.6
国外 Overseas	1級 Level 1	3,944	3,369	1,504	44.6
	2級 Level 2	4,835	4,186	2,418	57.8
	3級 Level 3	6,808	5,929	3,791	63.9
	4級 Level 4	9,266	7,942	4,836	60.9
	計 Subtotal	24,853	21,426	12,549	58.6
合計	Total	41,404	35,609	18,314	51.4

A: Number of applicants B: Number of examinees C: Number certified
D: Percentage certified

(注) 受験者数には「文字・語彙」「聴解」「読解・文法」のうち一部だけを受験した者の数を含む。

Note: The number of examinees includes those who did not take one or two of the three sections of the exam (writing/vocabulary, hearing, and reading/grammar)

Appendix 2

Short-term Japanese CAI experts attached to JSIST

	Time	Name/representation	Topic
1	June '88	Dr T Sato NEC	CAI education - SP charts - ISM
2	Oct '88	Mr Y Terashima NEC	Courseware deveplomeni using NEC PC-SCAI
3	Feb '89	Dr T Sato NEC	CAI edcuation - SP charts - ISM
4	March '89	Prof Suetake Kanagawa Uni.	Audio visual aid
5	July '89	Mr S Seya NTT	Effective development of teaching materials
6	Oct '89	Mr T Okamoto Tokyo Gakugei Uni	ICAI

7 Jan '90	Prof T Sakamoto Tokyo Institute of Technology	Educational Technology - CAI evaluation - Students motivation
8 June '90	Mr M Takahashi NEC	Usage of PC-SCAI - Auto scoring - Revised version of PC-SCAI
9 July '90	Mr M Moriyama NTT	Trend of CAI ICAI CD Visualization of concept
10 Aug '90	Miss M Kiyono NTT	Genki Amination software

Appendix 3

STUDENT EVALUATION FORM ON CAI COURSEWARE

90 students

SUBJECT: Lesson 8 & 9 CLASS : [✓ AP] / SA / AD*

1. The introductory lesson made it easy to use the computer.

   YES 80 NO 7 NOT SURE 2

2. I am learning a lot with this computer.

   YES 81 NO 1 NOT SURE 7

3. I would rather learn this material in a regular class than with this computer.

   YES 14 NO 52 NOT SURE 24

4. Taking the tests helped me know if I really understood the material.

   YES 44 MOST OF THE TIME 36 SOME OF THE TIME 10 NO 0

5. I would like to take more lessons on the computer.

   YES 82 NO 0 NOT SURE 7

6. The computer was available when I wanted to use it.

   YES 25 MOST OF THE TIME 19 SOME OF THE TIME 29 NO 9

7. These lessons have encouraged me to improve my basic skills.

   YES 84 NO 0 NOT SURE 6

8. The computer allowed me to work at my own pace.

   YES 55 MOST OF THE TIME 23 SOME OF THE TIME 11 NO 1

9. For (me), most of the work in these lessons was:

   VERY DIFFICULT 0 DIFFICULT 8 ABOUT RIGHT 81 TOO EASY 1

10. Should the JSIST continue to develop lessons for the computers?

   YES 87 NO 0 NOT SURE 3

*Delete where inappropriate

ENTERPRISE SKILLS AND TECHNICAL TRAINING

by

Gillian Anderson
and
Brian Murphy

Tea Tree Gully College of TAFE
South Australia

ABSTRACT

The aim of this workshop is to identify and explore the issues associated with the way learners acquire "Enterprise Skills" within the delivery of a traditional Curriculum.

These issues are examined in the context of the application of information technology to the learning process, particularly in Computing and Information System courses.

The workshop participants will draw upon their own experiences as well as current research (eg David Squires, Network Based Multi-user CAL, World Conference in Computing Education Conference, 90).

BACKGROUND

Australia is undergoing massive social, economic and industrial change. The need to restructure industries with a view to improving quality, efficiency and productivity in order to compete more effectively in world markets is recognised as a priority by both government and industry. This will require a new range and level of skills from our workforce.

The new Tea Tree Gully College of TAFE in Adelaide, South Australia is being built to respond to this need. Its Charter requires it not only to offer a range of programs which address skills shortages but more importantly to do so in a way which will ensure that its graduates are not only immediately productive but possess a range of non industry specific skills which will enable them to adapt to the rapid technological and sociological change. That is, students will be involved in learning experiences which will encourage them to be enterprising individuals, according to the Organisation for Economic Co-operation and Development (OECD):

"an enterprising individual is one who has a positive, flexible and adaptable disposition towards change, seeing it as normal and as an opportunity' rather than a problem. To see change this way, an enterprising individual has a security borne of self-confidence, and is at ease when dealing with insecurity, risks, difficulty and the unknown. An enterprising individual is able, even anxious to take responsibility and is an effective communicator, negotiator, influencer, planner and organiser. An enterprising individual is active, confident and purposeful, not passive, uncertain and dependent."

Tea Tree Gully College is also committed to training graduates more efficiently and cost-effectively than has been possible in traditional post-secondary educational institutions. College staff propose to do this through the use of information technologies, including video-conferencing, interactive multi-media, computer managed learning and computer based training.

THE CHALLENGE

Computer based training has for the most part been used as a substitute for teachers and has delivered content but what about the Enterprise Skills?

"Training for the future must emphasise behavioural skills such as group learning, a balance of co-operation and competition, adaptability, flexibility, research, planning and communication. Skill will no longer encompass a set of knowledge and manipulative procedures that can be expected to last a life time." (Professor Bill Ford, Australia Reconstructed)

TECHNICAL COMPETENCE

Responding to the needs of industry shouldn't mean just giving students immediately usable technical skills demanded by industry. We have a responsibility to give students some degree of personal security, that is, give them an opportunity to develop transferable, generic skills or Enterprise Skills. These include problem solving, resource seeking, negotiating and communication skills. These are the skills students at Tea Tree Gully will develop, using the curriculum as the vehicle. So that technical knowledge or the curriculum isn't the driving force but is the means by which students acquire the Enterprise Skills. Rather than have a module which students take called "enterprise skills" and another module called "microcomputer management", Enterprise Skills are developed necessarily while learning about microcomputer management. In other words, the acquiring of Enterprise Skills determines the methodology, technical competence determines the curriculum.

Technical skills are critical for entry into the workplace but Enterprise Skills are the key to maintaining jobs.

The acquisition of Enterprise Skills and Technical Competence in this way determines, for Tea Tree Gully the roles of the lecturer and learner. This in turn effects the Learning Environment and the application of Information Technology.

The purpose of the curriculum and the method of learning have to be interrelated. The methodology has to be based on the individual, and groups of individuals, engaging in participatory, problem-solving activities whereby the lecturer acts as a facilitator.

THE ROLE OF THE LECTURER AND THE LEARNER

Developing Enterprise Skills is a process of enabling students to be independent, confident learners who have learned how to learn. The situational leadership model is a helpful model for describing this:

High | | |	High Relationship Low Direction Style 3 ENCOURAGING	High Direction High Relationship Style 2 GUIDING
RELATIONSHIP		
| | | Low	Low Relationship Low Direction Style 4 DELEGATING	High Direction Low Relationship Style 1 DIRECTING
	Low ------------------------DIRECTION---------------------- High	

Adult learners move from Style1 through to Style 4. Initially they have low competency for the task and so need a high level of direction, as they become more competent the direction needed from a lecturer becomes less until they become independent.

The Associate Diploma in Computing which we will be offering at the College, starts with Preliminary subjects and goes through to Project work. By mapping these subjects on to the situational leadership model we can generally determine the level of direction needed from the lecturer. So that when students begin the course and have minimal technical skills they will probably need a high level of direction. By the time students have reached the end of the course and are completing Project work, they would require minimal direction from a lecturer.

ORGANISATION OF THE LEARNING ENVIRONMENT

The changing relationship between lecturer and learner means that the learning environment needs to be flexible. Students, initially, needing a high degree of direction from their lecturer may need a different learning environment than a student who is further along in their studies and requires a wide range of resources and little direction from a lecturer.

Students beginning at the same point in terms of technical knowledge, will probably all need a high level of direction from the lecturer initially. However, we would expect that students would move from needing a high level of direction to being independent at different rates. In order to cater for these differing needs, students need to be provided with a variety of learning experiences and resources. Computer Managed Learning could assist in not only tracking student progress but could also provide some direction and guidance for alternative learning experiences and resources.

INFORMATION TECHNOLOGY

Traditionally, Information Technology has been used to improve the effectiveness of learning by providing individualised instruction for students. Most computer systems for the management or delivery of learning are based on the assumption that learning is a passive solitary process.

The view embodied in the Tea Tree Gully methodology is that learning is an active, group process.

We will use Computer Managed Learning systems as a tool to provide learners with course outlines, lists of competencies and a selection of activities or learning strategies. In addition, the technology will be used to manage the assessment of competencies and maintain resource lists.

The choice of the learning experiences, however, will be determined by the learner, through negotiation with the lecturer. The technology will not be used the replace the lecturer nor to provide highly directed learning.

Computer based simulation and experimentation can, of course, provide active, group learning experiences.

The main challenge still remains - how to organise the technology to encourage group work and co-operation, particularly for groups which may be constrained in their ability to get together.

The use of computer-based message systems should provide a tool that can facilitate group communication. This would allow for individuals who cannot attend the College regularly to participate in group work.

If we were to rely on traditional application of Information Technology we could use the physical space efficiently, we could handle continuous intake efficiently, we could accommodate off-campus students efficiently. Individuals would not be held back by the group and could work on their own timeline.

Our concern is how effective is this use of technology in terms of developing Enterprise Skills such as working with others or as part of a team , communication skills, working collaboratively to realise group goals.

David Squires in his presentation at the WCCE 90 suggests five paradigms for computer network based assisted learning.

The guiding principles that he adopted in formulating the paradigms was a consideration of peer interaction in learning.

The paradigms can be summarised as follows:

1. Multiple standalone use
Individual work, not affecting other users.

2. Independent work in a common workspace.
Access to same copy of program, students work on the same task in an independent fashion. Model is changed for themselves and others see the change. e.g. Airline Reservations and Stock Market.
No communication between the students using the program - react to the decisions of others.

3. Individual contribution to a shared task.
Work of each student has effect on overall completion of a common task. Students assume roles related to the task.
Communication is implicit, not explicit.
Action of students are related through the observed results of the actions of their peers.

4. Group work with same or similar task.
Students communicate as they work independently on the same/similar task. Communication is affected via the network, access to shared resources via network. Collaborate via network on individual task.

5. Group work with a shared task.
Communicate as work on shared task. Software requires students to work in a dependent, collaborative way. Encourages collaborative learning.

Paradigms 3, 4 and 5 encourage students to work collaboratively on realistic and relevant tasks.

It is this kind of model of the organisation of Information Technology which would seem to be effective in developing Enterprise Skills.

What software is currently available to implement this model?

As a starting point, a college-wide Local Area Network based on a UNIX host system will offer both private and group work space together with Electronic Mail facilities.

The results of the work of groups will be incorporated into the College's resource collection but it will be of great interest to see if any record of the group's interaction can become a resource in itself. Even the ability of a learner to annotate College resource lists could be of benefit.

The value of computer systems in the Administration of educational institutions is not being questioned at Tea Tree Gully. The system must be structured, however, to support the relationships expected to develop between lecturers and learners rather than control it.

ENTERPRISE SKILLS AND TECHNICAL TRAINING

The qualities and attributes that we refer to as "Enterprise Skills" cannot be taught, but rather, we have to enable people to learn them. This means giving people the opportunity and support they need to learn things for themselves.

So this is the challenge - the Tea Tree Gully Charter is clear, we have to graduate students who have these Enterprise Skills and we need to do it cost effectively with the use of Information Technology. Is it possible?

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LEARNING WITH EXPERT SYSTEMS

by

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ABSTRACT

This paper explores the current applications of using Expert Systems for learning.

The education system has the social function of storing accumulated knowledge. Expert systems provide scope for storing and transmitting accumulated reasoning which can synthesise combined knowledge from multiple sources.

Three users of expert systems are categorised and their interaction with expert systems is discussed.

It should be remember that not only is more information available today, but a more sophisticated society is demanding higher standards and diversity in the outcomes of information use. The widespread adoption and use of computer aids, such as expert systems, is therefore inevitable. A further consequence is the trend to life-long learning. The combination of these factors offers potential for the innovative use of expert systems to underpin a 'learning-to- learn' culture.

1 Introduction

Information is expanding at an accelerating rate. One necessary outcome of this is the trend towards narrow specialisation, even within professions. It is becoming more and more difficult to take into consideration all the information necessary for effective decision making. One method of ensuring that comprehensive and up-to-date information is made available for decision making is the development of so called 'expert systems'.

This paper explores the current applications of using expert systems for learning, both in the educational system and in industry.

2 What is an Expert System?

Expert systems are computer programs that have one or more human experts' knowledge encoded in them. They are based on heuristics, or rules of thumb, and are often used where a quantifiable result can be obtained. They have also been increasingly applied to 'fuzzy' areas where confidence in a proposed solution can be expressed in percentage form and in areas where human expertise is expensive or scarce. The problems dealt with are usually very limited in focus, however they can be a valuable method of ensuring that comprehensive and up-to-date information is made available for decision making.

Expert systems provide scope for storing and transmitting accumulated 'reasoning' which can synthesise combined knowledge from multiple sources.

3 What Do Expert Systems Do?

Expert systems allow:

A Established experts to consult their 'computerised' peers:

B Potential experts, lacking experience, to have access to a wider range of expertise than their immediate workplaces or educational institutions can provide;

C End users to solve problems beyond their normal capacity.

Expert system applications that aid each of these three user categories abound. The range is wide, from the Northern Territory Land Council's expert system which contains the knowledge of tribal elder, Merle, for monitoring who has access to sacred sites; to auditing, insurance underwriting, geological exploration and network management trouble shooting. Rules contained in the knowledge base of an expert system can be several hundred (as in the famous medical diagnosis system, Mycin) to 7000+ (Peat-Marwick's auditing expert system).

Each of the three types of user categorised above utilise different interactional processes with an expert system. By doing so there is the potential to learn more about their domain of knowledge. How and what will the user learn? Learning is a difficult concept in itself, involving not only the acquisition of information, but also the discarding of information considered unnecessary. With this in mind, each of the three categories will now be discussed.

3.1 Established Experts

Expert systems obviously cannot exist without input from experts. Applying logic to the solution of a limited but well-defined problem and laying out personalised knowledge in steps leading to a solution, enables experts to become conscious of the strategies used to reach the correct solution. Experts can learn how to apply and extend their personal 'knowledge base'. When the author was building an expert system on rehabilitation strategies, the domain expert involved felt she had been given an invaluable insight into how she structured the logic of her decision making when she assisted in assembling the knowledge base. By making her knowledge and understanding of the process explicit, she critically analysed her knowledge base and felt she expanded her ability to use her knowledge domain (or expertise).

An expert can use an expert system to gain access to filtered information quickly. The classic example of where an expert would need filtered information quickly is a nuclear power plant. An expert operator may have 800 alarms in the first two minutes of a major malfunction. In such a short time it is impossible for a human operator, whether expert or not, to diagnose multiple problems involving such quantities of information. A more common example would be a plant shutdown in an automotive plant which could mean thousands of lost dollars. A real-time expert system could quickly diagnose the problem and in a matter of minutes offer possible bypass/corrective alternatives to minimise the shut-down period. Moore and Khanna believe 'such systems are mandatory for the success of the 'lights out' factory of the future, where human expertise to maintain and run the factory would neither be available nor can it be developed.'

Experts can also use expert systems to make timely, accurate decisions. Existing knowledge is locked into the system and a decision is made based on that knowledge, as when an experienced business manager uses an expert system to aid in formulating a business plan. The expert system will prompt on critical factors and allow better sensitivity analysis.

An expert may use an expert system as a real-time job aid to speed up a lengthy decision-making process. (Focus Technology has reported a case where bank auditing was cut down for an experienced team from 27 days to 3-5 days using an expert system.)

Experts, too, can learn from the structured knowledge embedded in a system incorporating information from many experts. Experiencing diverse ways of thinking can expand a personal knowledge base and give a different perspective by exposure to other insights and cross fertilisation. The same effect can be achieved formally or informally at meetings and conferences, however, browsing an accumulated and synthesised knowledge base at leisure may create a synergistic effect.

3.2 Potential Experts

These potential experts could be:

- Newly-graduated professionals who have a theoretical perspective on a subject area but lack experience, or

- experienced personnel who have the intuitive capacity to know the solution but lack a formalised understanding of why the solution is correct.

Both users are often motivated to gain expert status and both can gain by using expert systems.

These potential experts operate within today's information-rich society resulting in a need to have a better understanding of a variety of problem-solving techniques to manipulate sometimes large amounts of information and thereby arrive at a decision. Alternatively, these potential experts may well need to rely on being guided through a problem using a system to support them because of the sheer complexity or scope of the decision-making process. Benefit can be gained from an expert system in both these cases. Expert systems allow an 'institutional' memory to be put in place, one that allows a structured, consistent approach to decision making and can be updated as new situations arise.

The concept of an 'institutional' memory is relevant to both educational institutions and large organisations. In educational institutions, it may not be feasible to pay the fees associated with, for example, experts in corporate law to give lectures to students. This same legal expertise encapsulated in an expert system is accessible. In the commercial context, many large corporations are trying to capture the expertise of their aging experts before they retire, to make it available in the form of an expert system (eg toolmakers).

Expert systems allow the user to share the expert's knowledge by means of an explanation facility. In most systems the user is able to ask the system 'Why did you ask that question?' Although the response the user receives will almost certainly be limited in scope, the program user can trace some of the expert's reasoning path, ie the meta-knowledge about the system's problem-solving strategy. Some researchers offer a note of caution here, believing any 'mental mapping' resulting from using only the explanation facility may be fragmented, as the program-solving strategy is also to be found in the ordering of the rules, ie the logic flow, of the knowledge base. However, most expert systems are able to explain themselves by backtracking through the logic used to arrive at a question or conclusion. Users need to be encouraged, or even trained, to use this option.

As expert systems specifically set up for learning are rare in Australia's business environment, it is useful to look at an Australian program set up for learning in an academic setting, CGT-Rules. CGT-Rules ascertains Capital Gains Tax liability and is used by undergraduate students studying final-year taxation law at the University College of Central Queensland. The aim of CGT-Rules is to enhance learning by providing sophisticated held and explanation facilities. The developers believe that students' learning can be enhanced, without significant teaching expertise, by careful design, particularly of the explanation facility.

This concept of sharing of subject knowledge and reasoning strategies is conceivably the greatest benefit that can be gained from expert systems.

3.3 End Users

This end-user is the non-expert who uses an expert system for real-life problem solving.

One extremely successful example of an end-user situation is American Express, an organisation that, unlike bank credit cards, has no credit limit. With a rapid response to telephone authorisations being critical and the number of experts limited, credit authorisation, loss and fraudulent use of credit cards became a formidable problem. American Express resolved this situation by creating an 800 rule system after interviewing and using the knowledge of their five best credit authorisers. The resulting systems take information from 10 or 12 data bases, interprets the data and advises whether or not to grant credit. This is a situation where the American Express employee needs to use the system very carefully. Even, as in this case, a system user is being completely guided through to a final decision, it is important for users to have a good understanding of the processes behind the decision. Computer programs are fallible - they are only as good as their knowledge base and its structuring. There is always an exceptional case occurring which the expert system has not taken into consideration and which will need an adapted approach. The end-user should be able to identify these non-typical cases and refer them to human experts for a final decision. (Even though it is meant to be used in an 'end-user' situation, the American Express system can still be queried and overridden by the authorisers.) The more aware of the required objective and the reasoning process behind it, the more likely it is that effective decision-making will occur. To effectiveiy assess a decision system users have to be able to establish a mental map of the process so they can understand and critically evaluate recommended decisions.

It is possible to aid users in forming a proper mental model of an expert system by definite training interventions.

Computer based instruction has become an accepted technology both in industry and educational institutions. Computer-based-training (CBT) is suitable for teaching, eg the use of tools, such as spreadsheets, in business. Experts systems can teach the knowledge of the trade.

The penetration of CBT into industry is high. CBT took, however, some time to become an acceptable method of learning in industry. Greater use of personal computers and the greater number of computer applications now used in industry has accelerated its acceptance. Expert systems are gaining wider acceptance and use, although their progress is still slow. Personal contact with insurance organisations suggests the current training benefit of expert systems is seen only in terms of the explanation facility. One promising approach to be considered is using the expert system as a resource in conjunction with CBT. An expert system and CBT packages frequently share the same knowledge base, it seems advantageous to use them in complementary roles, providing a complete training package.

4 Conclusion

Information is not only more readily available and in larger quantities today, but a more sophisticated society is demanding higher standards and diversity in the outcomes of information use - be they products or services. The widespread adoption and use of computer aids, such as expert systems, is therefore inevitable. If they are to be a vital part of business (and education) their effective use must be enhanced by astute training strategies.

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IMAGE PROCESSING - IMPLICATIONS FOR EDUCATION AND TRAINING

by

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ABSTRACT

Image Processing Technology has the potential to cause significant change in many practices in education and training. This is mainly due to the suitability of the information handling capabilities of this new technology to solve many of the communication and storage problems associated with the vast amount of material that education and training institutions use in their daily operations of administration, instruction and support services.

There are two highly related processes encompassed by image handling technologies:

- Image capture, manipulation and dissemination. Each image may be regarded as a virtual 'picture' of a document which is scanned and temporarily held in internal memory for transfer to some other device which would most likely be more permanent local storage or for communication across a network for other purposes. The image of a text, graphic or photographic reproduction may be manipulated in some way by, for example, reading a text document with an Optical Character Recognition device to produce a text file, adding an "overlay" of text or writing , attaching an overlay of voice (as done with the WANG Freestyle product) or the image may be cropped and/or 'pasted' into another document. Image documents can be transported to another station as a facimile document.

- Image storage. Image storage requires gigantic amounts of memory for storage. Images must therefore be transferred to computer compatible, easy to use, storage devices. These devices must be relatively inexpensive (when compared to the main competitor -paper); provide more efficient access (be easier to retrieve that paper storage and at least competitive in terms of volume and speed of access with hard-disk storage) and offer relative permanent storage (the safe storage period at the present state of disk technology is between 10 and 50 years).

Progress and convergence of new techniques and hardware production in both these areas has ushered in an image handling technology which has profound implications for the education and training sector.

Bridging Technology.
In the first instance, image-based information technology may be regarded as a "bridging technology". The education industry is not highly technologically based - computer or otherwise - but it does handle vast quantities of raw date, information and resource inventories. Little of this information base is touched by modern (Von Neuman) computing. Certainly, computers are used for management and administration (especially in overseas educational institutions), for research and increasingly for Computer Based Education (Computer Assisted Learning - CAL, Computer Based Training - CBT) and in service areas such as a university/ college or corporate library.

However, it is reasonable to assume that the proportion of computer applications in education and training in terms of information storage would not exceed the proportions of information storage experienced in business and industry.

As can be seen from the accompanying figure "Data Storage Modes" (Figure 1), approximately 5% of information, world-wide, is stored on media in the form of chip, disk, tape or microfiche. The remaining 95% is paper-based with the ubiquitous "four draw filing cabinet" epitomising the extent of hardware involved! Of the non-paper proportion, less than half is in random access/ computer retrievable form. The proportion of computerised information in education would probably be no more than a tenth of the percentage distribution for business.

The reason that computer technology is not as widely used is of course, related to cost - not only in dollar terms for hardware but the high demands on time for operatives to input such information into a database. Some documents, for example handwriten insurance claim forms, or university admission documents, do not lend themselves readily to classification, indexing in detail and subsequent entry into a traditional computer system. In addition it is often the case of needing to retrieve the whole document rather than information held in one specific field.

Another difficulty is related to the nature of the documents to be stored. Many documents are a mixture of text and graphics - such as an insurance accident report with a freehand drawing or a page from an engineering text. Or it may be predominantly graphic such as a geographical map. Traditional computing hardware and software have made it uneconomical, unsuitable and often impossible to handling information in these structures and compositions.

However, both education and training deals with extraordinary amounts of data, graphics, pictures, still and moving images, total text documents (with virtually an infinite variety of font and layout combinations) and information mixes of text with other graphical representations, such as line drawings, cartoons, sketches, maps, captured or reproduced computer screens, black & white and colour photographs.

Transfer of information from one medium to another has been one of the main obstacles confronting users and potential customers in most areas of application and especially in education and training where expenditure on equipment has been regarded as an extra or even a luxury item. The incompatibility between hardware and software is well known. Similarly, the incompatibility between versions of software releases is also widely experienced. These hurdles and barriers have made it difficult

DATA STORAGE

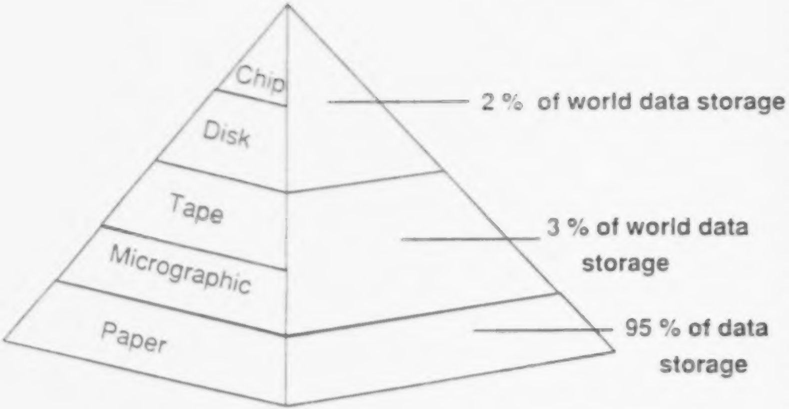

Chip
Disk
Tape
Micrographic
Paper
2 % of world data storage
3 % of world data storage
95 % of data storage

Figure 1: DATA STORAGE MODES

or impossible to take advantage of the positive aspects of computer based information handling, for instance, the speed of retrieval of files, the ability to add or change a document or database and the power of electronic distribution.

The difficulties of CAL development, even using special Authoring Language/ Systems has restricted the use of computers for learning and instruction. Instructional Design, coding/ programming and graphic art work all demand special knowledge and production expertise. Although fully developed CAL packages and multimedia presentations have proved effective in many disciplines and many training environments, there remains a large gap between current practice in instruction, which is largely paper-based and the employment of educational technology. Image processing can bridge this gap.

Image based technology is particularly suited to the current processes and needs of education. The effect of this technology will be to satisfy immediate needs for more efficient procedures and to provide a process and methodology more commensurate with current practice.

Benefit to education and training.

There are four areas in education and training which will benefit greatly from image handling technology:

1. Administration
Like all large organisations, educational and training institutions deal with 'mountains of paper-work'. Most of these documents need to be indexed, stored, retrieved and viewed wholistically. Many of these documents need widespread access, although some require special control and restricted distribution. Administrative documents suitable for image processing in the areas of admissions, management and general communications include:

Admissions:
- Application forms.
- References.
- Transcripts of previous performances (often computer printouts but not obtainable as a data file).
- Certificates of attainment.
- Honours and awards documents.
- Written works, exhibition portfolios
- Test Data, (raw data or grouped data)

Management:
- Calendar or program of course offerings.
- Financial records (probably the most computerised activity)
- Marketing and publicity information
  - Newspaper clippings
  - Job vacancy documents
- Buildings and grounds information:
  - Site plans and maps
  - Security

        - Fire
        - Electrical
        - Air conditioning
        - Computer network

- Communications:
    - Corporate goals and strategic planning documents
    - Correspondence and inter-office memos
    - Reports
    - Submissions
    - Minutes of meetings

2. Services.

- Information services:
    - Library
        - Reserve
        - Special collections
            - maps
            - audio/visual collections
            - historic documents
        - Journals
        - Book - table of contents, indexes
        - Archival material

- Campus Information
    - Visitor information
    - Conference information and directories
- Student services:
    - Health
        - Medical records
        - X-ray
    - Student handbooks
    - Sport facilities
    - Marketing information

3. Teaching and Instruction.

- Reference material
    - Journal articles
- Resource material
    - 35mm slides
- Graphics
    - 2D and 3D graphic stills and animations
- Course outlines
- Professional papers
- Staff presentation papers
    - Seminars by visiting faculty
- Student assignments
    - Submissions
    - Return and marked (with "comments")
- Reading lists

4. Research and evaluation.

- Proposal submissions
- Progress report and/or documentation
- Final reports
- Research literature

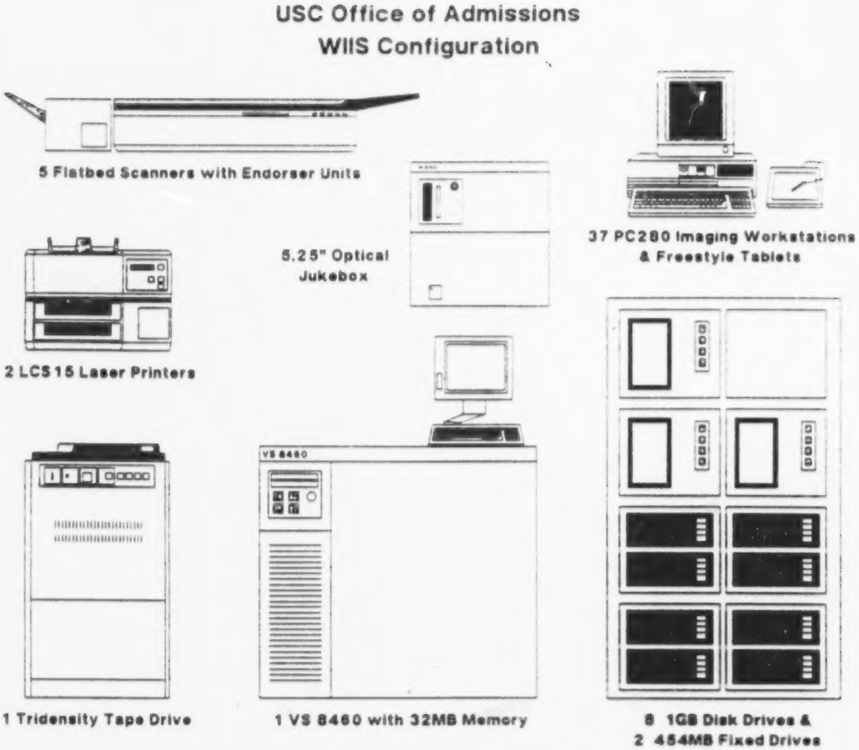

USC Office of Admissions
WIIS Configuration
5 Flatbed Scanners with Endorser Units
5.25" Optical Jukebox
37 PC280 Imaging Workstations & Freestyle Tablets
2 LCS 15 Laser Printers
VS 8460
1 Tridensity Tape Drive
1 VS 8460 with 32MB Memory
8 1GB Disk Drives &
2 454MB Fixed Drives

Figure 2: USC Office of Admissions - WIIS Configuration

The above list exemplifies the diversity of both the source of documents and their composition. At the present time almost all of this information is in paper form with very restricted access or distribution. From an organisation point of view, be it an educational campus or even a small training establishment, the need for greater access and greater flow of information becomes evident. This can be achieved through imaged-based technologies.

Case Study I -

University Admissions, U.S.A.

The University of Southern California is in the process of implementing and evaluating an image-based document handling facility in the Office of Admissions. Under the guidance of the Director, Mr Tom Myers, a full implementation of the WANG - WIIS system is underway.

The configuration of equipment is set out in figure 2, "USC Office of Admissions - WIIS Configuration". Hardware consists of input devices such as flatbed scanners, 'Freestyle' graphics tablets and computer terminals. Storage is in the form of tape drives, large disk drives and a 5.25" optical jukebox. Computers include a mini and 37 image workstations. Document handling is currently conducted on two parallel systems -the Wang as the primary hardware and a Prime mainframe acts as back-up (see figure 3, "Indexing on Two Mainframes"). In a period of more than six months the back-up system has not been required.
Actual document flow follows the path set out in figure 4, "Optical Filing Document Flow". This image-based information system has facilitated:

- A reduction in staff actually handling and retrieving paper documents.
- Considerable increase in quality control through re-deployment of staff and tighter processing control.
- A complete review of storage space and costs. This has resulted in large areas being freed from paper based storage. An off-campus facility which had not been referred to over a six month period was disbanded resulting in a considerable cost saving.
- Redistribution of original paper documents. Original documents are now forwarded to appropriate university departments for review and storage or disposal on their own initiative.
- Very fast location and retrieval of documents provides a much more efficient service to applicants and to internal departments. In addition, the Office of Admissions has been able to forward, as facsimile documents, image 'copies' to external institutions for review or, in a few instances, where the original was mislaid !

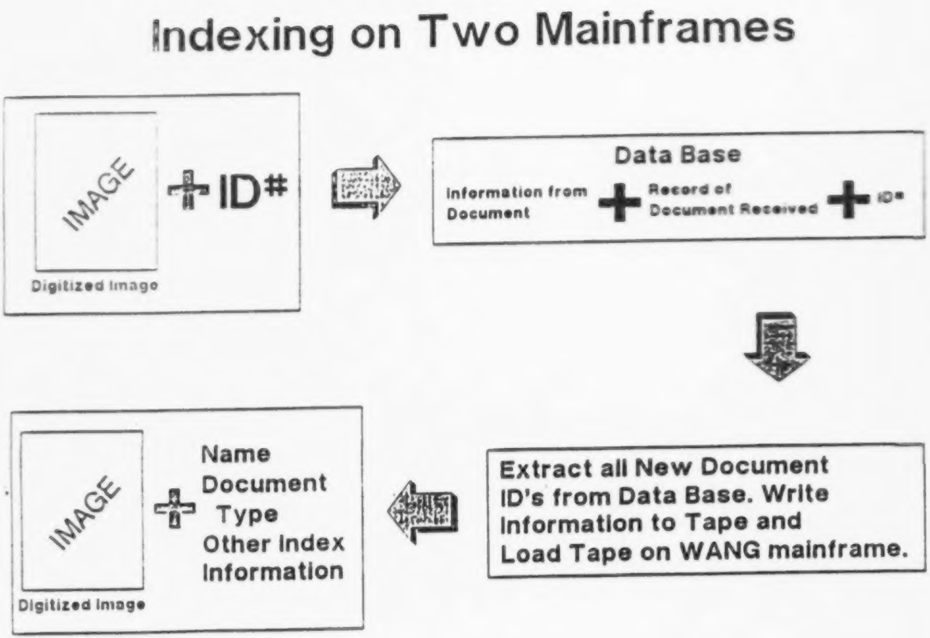

Indexing on Two Mainframes
IMAGE
ID#
Digitized Image
Data Base
Information from Document
Record of Document Received
ID#
Extract all New Document ID's from Data Base. Write Information to Tape and Load Tape on WANG mainframe.
IMAGE
Name
Document Type
Other Index Information
Digitized Image

Figure 3: Indexing on Two Mainframes

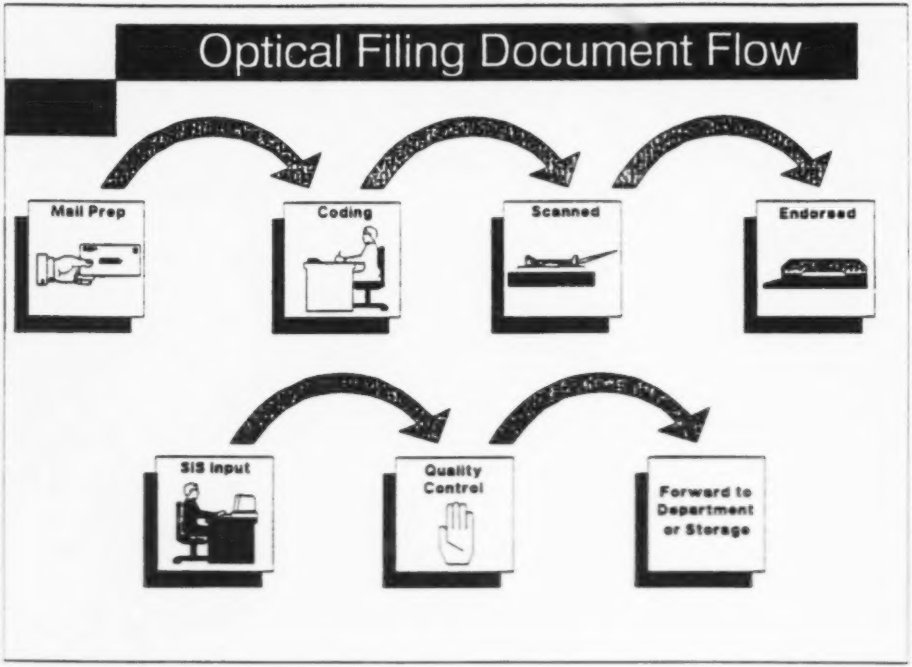

Optical Filing Document Flow
Mail Prep
Coding
Scanned
Endorsed
SIS Input
Quality Control
Forward to Department or Storage

Figure 4: Optical Filing Document Flow

In summary, it is worth reporting that this is a highly successful installation of image processing technology and confirms that the technology to implement such a program is available to-day in a stable and reliable form. Above all, a much more efficient service is provided at a considerable cost reduction. Internal departments and external clients have obviously benefited greatly from this initiative.

Even this very successful and impressive installation at the University of Southern California has room for extension of service. Linking this system into a campus communications network will improve access and usage. With a fully configured system and expansion of storage - which is rapidly becoming cheaper - and networking there will be no need for separate departments to have paper storage of original documents. With security control, designated personnel will have open access to admission documents from their computer terminal, on request.

Case Study II -
Proposed Image Handling Study in Australia.

This section is a summary of the directions and current activity of a joint image-based information system Research and Development project between Bond University and WANG Australia.

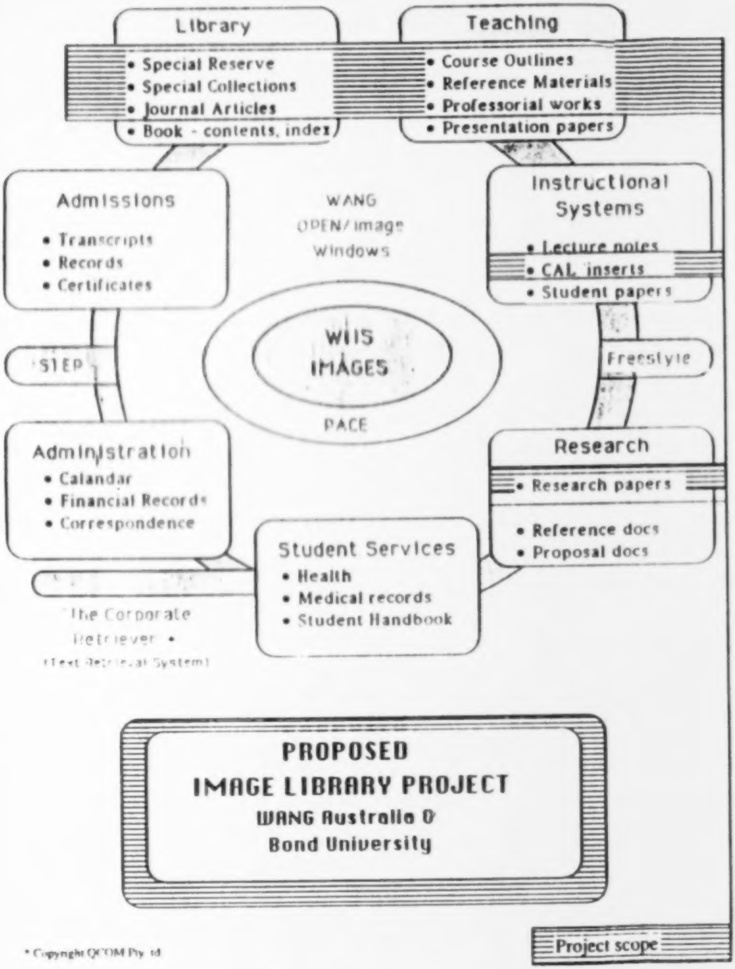
The project leader at Bond University is Dr John Barrett, Associate Director (CAL), Office of Computing and Information Technology in cooperation with WANG Australia. The equipment employed will be similar to that described in the University of Southern California Admissions service described above. A general 'conceptual model' is outlined in figure 5.

The purpose of project, *WISP*, is to develop a workable image document handling facility applicable to Higher Education libraries and corporate library information systems and investigate the feasibility (cost/ benefit) of its implementation. A unique application is the development of technology for integration of the image system into teaching and training environments. In addition, special applications associated with each disciplinary area, for example law, will be pursued as a separate area of evaluation and assessment of potential commercial viability.

The goals of the project are to:

- Develop an image-based document handling system to replace much of the traditional handling of restricted/ high demand documents as found, for example, in the "reserve" section of a library.

- Implement a campus-wide image-based information system and monitor both its developmental problems and its effectiveness.


Library
• Special Reserve
• Special Collections
• Journal Articles
• Book - contents, index
Teaching
• Course Outlines
• Reference Materials
• Professorial works
• Presentation papers
Admissions
• Transcripts
• Records
• Certificates
WANG
OPEN/image
Windows
Instructional
Systems
• Lecture notes
• CAL inserts
• Student papers
STEP
WIIS
IMAGES
PACE
Freestyle
Administration
• Calandar
• Financial Records
• Correspondence
Research
• Research papers
• Reference docs
• Proposal docs
Student Services
• Health
• Medical records
• Student Handbook
The Corporate
Retriever •
(Text Retrieval System)
PROPOSED
IMAGE LIBRARY PROJECT
WANG Australia &
Bond University
Project scope

* Copyright QCOM Pty Ltd

Figure 5: Image Library project

- Examine the feasibility and effectiveness of the storage of a large volume of documents in "image" form and its incorporation in teaching/ learning, research and administrative functions.
- Establish which is the most efficient method of information distribution over a network, both local and wide-area, in an academic environment.
- To evaluate the image handling system in benefit/ cost terms in relation to process activities and overall outcomes.

Enabling Objectives.

To accomplish the above goals the following tasks need to be achieved:

- Establish a joint-venture agreement between Bond University and WANG Australia
- Form a project management infrastructure
- Allocate, mount and house WANG image equipment
- Train operational personnel in the use of image handling equipment
- Design and develop the library document database
- Design and develop the database management and retrieval system
- Locate and scan selected documents into the database
- Introduce and train users in system functionality
- Design and implement learning exercises and incorporate image handling activities in CAL exercises
- Establish data gathering procedures for the evaluation process
- Implement network distribution and access on an increasingly wider scale
- Negotiate with a third party government institution (probably another "Unilink" university or possibly a government library) to participate in the project on a wide-area network
- Consult with the Centre for Information Technology and Communications and generate a National Procurement Development Grant Proposal for Product R&D

Product outcomes.

Actual products which will result from this R&D effort will include:

An image management database and delivery system applicable to Tertiary Education and corporate libraries.

An Evaluation Report on the development process and the technological considerations in relation to library/ CAL functions.

A demonstration "CAL package" operating with image processing.

Future R&D guideline's and grant proposal(s).

Process outcomes.

A number of processes will be monitored which will result in:

- Decisions about which types of documents are suitable for image handling and the process of capture and their viability in terms of usual library functions.
- Staff and students using a working model of a library image database (Law in the initial stages).
- Selected library reserve section documents delivered under imaging.
- Schools and campus network access through the image database.
- Co-ordinated activity in selected library resource and learning resources.
- Co-operative research venture within the "technology quadrangle".

Developmental Stages

The Project proposes the combination of WANG image handling and storage technologies, the development of specific software and its application to the provision of an image database and document handling facility on, and emanating out of, Bond University campus.

More specifically the project is developed around a traditional library function and evolve through as number of stages, a brief outline of which appears below:

Stage 1. Commencing in the Law collection in the Law School building a sample of 'high demand' documents will be scanned into the evolving library database. *Staff usage will be monitored and followed by a student exercise during* database construction. Data will be gathered about document processing. Investigations will begin on networking with some trials of faculty input of documents.

Stage 2. Moves to the Reserve Section of Bond University main Library. This is a situation where traditional library operations remain relatively untouched by advanced information technology. Documents are held off the shelves for restricted access and/or limited amounts of time. Materials in this section of the library often have high demand by students and staff. Even though multiple copies of reserved documents may be provided, they are open to loss or abuse.

This project continues to provide the necessary technology to organise a selected representative sample of documents in image form and evaluate the effectiveness of the capture, storage and retrieval process, particularly in relation to the expanding database. Law documents will be accessed over available parts of campus network which will be evaluated during this stage.

Stage 3 (A). In this phase, document scanners will be introduced in each of the four schools. This will allow faculty to directly input documents relating to their teaching programs and research activities.

(B) Students input will be possible in this phase of stage three. For example, students will be able to 'hand in' assignments for evaluation and feedback. This phase implements a number of Computer Managed Instruction (CMI) features.

Stage 4. In this stage "open" access will be made available through the Bond University Local Area Network (LAN) which consists of a fibre optic cable network, Ethernet linked to Apple Talk networks. This stage will provide considerably more wider distribution of library documents.

Stage 5. This stage is concerned with expansion of the teaching / learning functions. Computer Aided Learning (CAL) courseware will incorporate image documents directly in the CAL package or users will be able to dynamically access image documents; for example, reference material, on a needs basis from within a learning encounter.

Stage 6. This stage is concerned with the distribution of documents on a Wide Area Network (WAM). The image database services will be extended to the Research Park on Bond University Campus as well as to other higher education members of Unilink. Unilink is an information technology initiative which provides access to the four major tertiary institutions of S-E Queensland - Griffith University, The University of Queensland, Queensland University of Technology and Bond University.

The total project will be evaluated at the conclusion of stage six.

Summary of Outcomes.
In general, the desired outcomes are:

- An image-based library information system suitable for large Tertiary Educational organisations and systems, local and state government libraries and corporate information centres.
- Methodology and technical 'know-how' associated with the introduction of a campus wide and area wide image delivery network for Higher Education and corporate libraries.
- Technology related to image document processing in CAL and CMI and associated educational activities.

The proposed project, which is in advanced planning stages, will provide a vital demonstration of the potential of image processing for document handling on a modern high-technology university.

Image processing technologies have the potential to contribute to information storage and handling internally in an organisation and also to contribute to a wide-area network arrangement such as those proposed in "open learning" or any multiple-access modes of education and training.

Open Learning and Business/Industry Training (Teleconferencing).

The aim of Open Learning and its associated technology, teleconferencing, is to provide equal opportunity for learning and instruction to anyone regardless distance or time. The concept of Open Learning embraces the notion of learning at a distance (Distance Education) for formal courses of business/ education training. Possible because of a tradition set by the older "correspondence courses" much of the materials in these courses remain print-based. Print has often been supplemented by audio cassette, occasionally by video cassette and rarely by computer-based learning. Many external programs, and here business often leads the way, employ teleconferencing, either audio, video-graphic of video as a communications mechanism. However, with the exception of facimile transmission (sometimes from an electronic whiteboard) or graphics and/or video, much of the participants notes, prior-reading or support references (manuals of lesson material) is still handled as hard-copy, that is, paper-based typed notes, printed materials and books or journals.

Most of the materials needed for teleconference meetings or open learning encounters could more easily be handled with image based storage devices. With the rapid decline in storage coast and the astounding increases in storage capacity the options of having one large database or distributing ALL course material to a local node or to the student's machine is quite feasible. Image processing is the only technology currently available, or under development, which will satisfy demands of instructors, students and resource administrators to provide much better instructional services at less cost. Access time can be improved markedly, storage and access of resources greatly improved and delivery costs reduced significantly. Delivery of open learning courses and business/ industry training using imaging will make current efforts (with the emphasis on energy expenditure) look like mail delivered in times of the pony express!

The management of learning resources will be significantly enhanced image processing technology. Questions of both access and control will be addressed more equitably through this technology.

Specific areas of development in tertiary education/training include:

The Library. The obvious need for storage, retrieval and dissemination of information. In the future, much of the library information will in "electronic form" and a great proportion will most probably be image documents.

The Student Workbench. Development of graphics or multimedia workstations of high screen quality and high processing speed are required for imaging. This can also be achieved through high performance PC's operating under 'windows'.

Graphics. A number of disciplines are making use of graphics for diagnostic, planning and analysis or instructional purposes. These would include engineering, architecture or medical departments. For example, at the University of California, Professor Arthur Toga of the UCLA School of Medicine, is using 3D graphics in Neurological modelling of sections of the brain. The storage and retrieval of thousands of cross-sectional images (in colour) is computationally demanding and in ideally suited for image storage and manipulation.

CAL. Computer Aided Learning demands large quantities of textural, graphic and mixed informational screens. Image processing will play a revolutionary role in providing input, processing and output enhancements.

Summary of Education/ Training Image Market Opportunities in Australia.

Developers, manufacturers and suppliers have limited opportunity for image marketing in the short term. The marketplace is still quite uninformed so much effort will be required to bring this technology to the attention of managers and higher executive. However once the advantages are communicated and barriers to technological innovation broken, a reasonable market size exists in formal education -especially tertiary education, in training departments (business, industry, public service, defence) and the professions. Niche markets could well be seen for education/training in professional fields such as banking, insurance, medical, architecture and engineering. Areas of opportunity in education will open up in large file management such libraries, resource centres and administration, such as admissions, employee/ student records and information services.

For the Australian supplier there is a limited market in -

Hardware:

Most of the market will be addressed, if not satisfied, by the large multinationals which have identified image storage and image management as the opportunity area for the next decade.

Software:

There is still considerable opportunity to use the advanced know-how of educators, trainers and researchers in education in Australia to develop instructional packages, authoring processes and storage and retrieval software/ courseware.

Communications:

Opportunity exists for communication research and development to improve the quality and lower the cost of transmitting the quantity of data image processing entails.

Effects of Image Processing across the Education/Training Spectrum.

Education and training demands the delivery of vast amounts of information in disparate forms. This takes the form of support resources such as textbooks, library reference materials, audio/video resources, computer-based information and learning materials. Many of these documents are of special form, such as historical papers or map collections which, up till now, have been handled by a traditional methods which go back hundreds of years. These practices relate to the concept of "library", the notion of "book" and a paper-based society. The procedures for handling information in paper-based form is highly labour intensive, requires tremendous storage space and limits access and communications. Actual delivery of information is this traditional scenario is a major task involving specialists such as librarians, media personnel and resource staff as well as teachers/ instructors. Much of the processes in the service sector of education and training will change with image processing technology.

The teacher/ lecturer/ instructor will also be affected by image related technology. The "mechanics" of organising the curriculum; locating, storing and delivering information resources "at the right time" is a major, labour intensive, task. Curriculum documents, student records, library references and resources, the course text, additional reading materials (often only held by the instructor) need to be organised and collated for purposes of learning and instruction. Computer Based Learning has attempted to address many of the problems of resource delivery and instructional management but, as pointed out earlier, this has had only moderate acceptance because of the barriers of capture and delivery of much of the information which remains in paper mode.

The Computer Managed Instruction approach uses computer programs to co-ordinate instructional resources and learners through scheduling techniques - mostly relying on testing and off-machine activities such as finding a library text and 'researching' some set questions. Image technology will change this process considerably as documents or reference manuals or maintenance handbooks now only accessed manually will be able to be called up on-demand to the learners screen.

It is now possible using image processing technology to incorporate additional readings, reference articles, graphic representations, copies of historical documents or images on videodisc into a computer-based learning experience. The authored instructional sequence can "call up" the desired material from the image database when needed. It should be noted that this approach treats all images as 'data' which is separate from the instructional 'control' program. Not only does this provide for much superior programming/ authoring but resources are not repeatedly imbeded in the program. Changing the program (the instructional sequence) or the image database is also more efficient when they are separate.

Resources must be built up and coordinated in the delivery of a course or training program. This may be likened to the project management demands faced by building contractor. Many different resources of different size and shape must arrive 'on-site' from different locations - at the right time, often "just-in-time"! The teacher/ lecturer/ instructor will have to repeat this process in a teaching cycle. Image processing allows a database of images to be created which can be accessed across a network by all instructors and learners. Document preservation, control of access and monitoring of usage are all possible with these systems.

Acceptance of Image Processing Technology in Education and Training.

For any new technology to become accepted it must be demonstrably superior (cost/benefit) to current practice - and at least as easy to use. This statement explains why there has been a reluctance to incorporate CAL in the mainstream of education and training. However, imaged based technology, especially when costs inevitably fall and compatibility increases, has the potential to provide revolutionary impact on the delivery of instructional packages and learning resources.

The implementation of image-based education/training resource requires considerable capital outlay. Entry level into the market will preclude almost all secondary and primary school education. Only advanced and venturesome education university/college and training organisations will embrace this technology at the outset, and only then when they are thoroughly aware of the actual advantage to be gained from image-processing.

In conclusion:

- Image handling technology is more suited to the vast information demands of tertiary education than any other sector and it may be that market segment that opens up first. Professional Education in Business, Insurance and Banking may "pave the way" as personnel in these areas will become more familiar with imaged-based applications and understand its potential for information transfer. Also, such industries, having the technology at hand for customer service and internal management, may embrace image technology to supplement their training efforts.

- This technology is just as important to the information providers in an organisation (eg, the library) and the administration as it is the training department or in support of the teaching function. This is an unusual position for the training department or teacher to be in and it may well be that image-based technology provides the catalyst for much co-operative exploration of common resources. Thus, from both a marketing viewpoint and from the perspective of a change agent, this technology offers at least three viable windows of opportunity for innovation.

EDUCATION AND THE INFORMATION TECHNOLOGIES; A FUTURES VIEW

by

Marjorie Carss
Richard Grice
Peter Galbraith
and
Merle Warry

ABSTRACT

This paper is a report of a futures study where the research problem was to identify skills and abilities in the domains of literacy, numeracy and basic science knowledge that will emerge as being important foci for secondary and tertiary education in the decade to 1998. The emphasis will be on changes stimulated by a burgeoning information society and its interaction with the curriculum, the school, college and workplace.

Increasingly rapid developments in the information technology means that concepts of competence will undergo continuous and accelerating change as industry, commerce and the social context take up and respond to these developments.

The study sought to identify the target skills and abilities perceived as current and future needs so that new expertise can be developed and unveiled deficiencies addressed in the context of a dynamic rather than a static view of education.

EDUCATION AND THE INFORMATION TECHNOLOGIES: A FUTURES VIEW

by

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Richard Grice
Peter Galbraith
and
Merle Warry

The University of Queensland

The information technologies increasingly feature in educational debate, both with respect to policy and to practice. At a practical level it was reported as long ago as April 24, 1989 in the Sydney Morning Herald, that

> Computer technology has taken handwriting out of the business world and it is only a matter of time before most people write their personal letters on a machine.

At the policy level the House of Representatives Standing Committee on Employment, Education and Training considered the issue of choice and technology of learning in their report "An Apple for the Teacher" (Brumby, 1989). In addressing the interaction and mutual impact between technology and the teaching profession the following points emerged.

- The successful application of technology in education depends not so much on the technology as how it is managed.
- Teachers have the most direct influence on the management of technology in education and are the group whose role will be most directly affected by technology.
- To interface adequately with technology teachers require facilitating factors including: enthusiasm to use the technology, adequate training, informed and supporting advisory staff, appropriate hardware, and software that is both compatible technically and with teachers' philosophies.
- Educational technology will lead to changes in teacher roles by its rate of change and associated social and economic effects. Teachers need training and support to take best advantage of potential changes.
- It is reasonable to expect a degree of resistance to innovation borne of fear of the unknown combined with scepticism. Teacher resistance can be a potent barrier to the application of technology in education.

- Technological change will make some teaching tasks unnecessary but will create new and different teaching tasks.
- One of the greatest obstacles preventing progress in the use of technology is the lack of experienced practitioners capable of giving high level leadership.

This report was published after the study was completed. The summary above is essentially in agreement with the views expressed by panellists in the study. The last statement is the one of greatest concern to educators at all levels, as it is a view expressed by all groups.

Extravagant claims have been made for the educational power of some of the information technologies.

> There is little doubt that micro-computer controlled video-disc systems represent the most potentially powerful communication device in the history of instructional communication. (Jonasson, 1984.)

Others, such as Ellul (1964, 1980) and Winner(1977) have perceived an inexorable development of technology that generates change and sets patterns of historical development within its own autonomous self.

> We know the definite risk that humanity is made to run by the growth of bacteriological, chemical, and nuclear weapons, as well as by the general pollution of air and water, the domestic and agricultural use of countless chemical products... But none of this matters; we must, above all, use what technology puts in our hands. Ellul (1980) p. 235 in Watkins (1986) p. 5.

Within this world view there is little choice for those in education - technology will come to dominate the classroom and the ultimate choice for teachers will be to adopt or perish.
As Winner puts it, human choice becomes illusory since

> ...technology is now a kind of conduit such that no matter which aims or purposes one decides to put in, a particular kind of product inevitably comes out. (Winner, 1977, p. 278)

Watkins (1986) argues strongly against the deterministic position which he sees as disempowering. He argues that education should adopt a critical approach to technology through which its legitimacy, its political foundations and power base should be subjected to scrutiny. In his view, schools should not respond in a functional fashion to needs defined by industry, and technology imposed by bureaucracy. Rather there should be an examination of the practices and effects that emanate from the exercise of choice in the development and utilisation of technology. This argument applies equally to all classrooms and the world of work. Watkins would take issue with many of the assumptions underlying the Brumby report.

Spitzer (1987) identified three factors which he believes explain why educational technology has not achieved its past potential. Firstly, there has been a values contamination whereby the prime function (i.e. efficacy as a learning scheme) is adulterated by other values such as aesthetic appeal. Secondly, there has been a leadership dilemma - who will take effective charge to rationalise the "quagmire of individuals, groups, and interests that claim a part share in the educational technology enterprise"? In other words, there is a perceived major managerial/leadership problem that remains unsolved.

Thirdly, and most importantly, Spitzer distinguishes between tactical and strategic approaches. The common tactical approach is opportunistic - give many educational technologists a medium and they will find every educational problem needs it, manufacturing suitable problems where they do not already exist. Strategy in contrast seeks an understanding of the total system before designing a course of action aimed to take account of all significant features of the situation.

> The history of Educational Technology is littered with tactical failures: media, hardware, and software that didn't catch on. Tactics will almost always fail in the long run. Without a grand design, no technology can succeed.

The Problem

A cursory review of the literature on education and technology reveals a variety of conflicting views. Some of those noted above intend to and can influence the acceptance and effective use of information technology in education. The variety of views and opinions derive from different sources, such as those described below.

There are those who have an ideological objection to technology per se. Some object because of an anticipated devastating practical effect on the work place with consequent social inequality and loss of dignity of the individual. Others view technology as an instrument of power wielded by commercial and political masters. Both types of objection lead to opposition to the use of technology where the classroom is viewed as one head of a hydra.

In some quarters there is fear that, despite assurances to the contrary, the place of the teacher will be usurped rather than assisted by technology. Others sense a threat to their self-esteem rather than their job when the use of technology is equated with being up-to-date and effective. Those not using technology feel 'put down', a feeling exacerbated at times by resentment towards opportunistic colleagues who gain kudos through the use of the new technologies. Others actually fear the technologies, either technically or academically, and can be bemused and intimidated by the jargon used by their colleagues. It is not surprising that, without support and assistance to master the details of the various technologies, many make a decision to reject them. Genuine concerns have also been expressed about the poor quality of much soft-ware and the unsatisfactory way that technology has been used in learning settings. The cost-effectiveness debate requires much more reliable data than has so far been forthcoming from classrooms. There is also concern about the lack of strategic planning in the sense of Spitzer - too much piecemeal provision without a supporting strategic plan.

For example, hardware is supplied to institutions without an adequate staff training scheme to articulate between the technology and the curriculum. Spitzer's reference to the quagmire of individuals, groups, and interests that are stakeholders in the educational technology trade highlights the complications that ensue when political, commercial and educational values meet.

The Research Question

The multitude of different opinions and emotions affecting the debate on the use of information technologies in education complicates the task of planning for a productive educational future. In response to this situation, the research reported here set out to obtain information that would address the following basic question.

What will be the major information technologies in use in secondary education in Australia in ten years time (i.e. 1998) and what are the implications and opportunities for forward educational planning?

In particular, what is the likely impact of the information technologies on skills and abilities in the areas of literacy, numeracy and scientific knowledge and on the social context of learning?

Methodology

In an area in which feelings run so high, the problem of eliciting accurate information from group situations is exacerbated, there is too much room for individual domination, personal put-down and the escalation of prejudices. The "Delphi" technique (Turoff and Linstone, 1975, Weatherman and Siverson, 1974) eliminates committee activity through a sequence of controlled polls that are characterised by individual inputs, anonymity, and interactive reflection. Many versions of the procedure have been derived from the "classic" procedure originally developed by the Rand Corporation.

In this application a selection of information technologies and associated educational issues were identified from the literature. Traditional technologies such as transmission of knowledge through paper resources and by blackboard were included as well as the newer electronic types.

In Round 1 a structured questionnaire was sent to all panellists (141 respondents) in which they were asked to respond to the anticipated use of the technologies in 1998 with respect to nominated educational issues, that is, using a ten year forecasting period. Simultaneously they were invited to provide written comments on any or all of the questions asked and to nominate additional technologies which they believed should have been included in the original set. From these responses a further five technologies were added to the original twelve "technologies" listed in the first round.
(Note: Each panellist received three questionnaires: each received the Information Technologies and Social Context questionnaires together with one for either literacy, numeracy or science knowledge. The other areas have been reported on separately.)

In Round 2, the summarised results of the first round were distributed to panellists. Where 67% or more of the panel had agreed on a response, the percentage agreement figure was provided, and individuals asked to indicate whether or not they agreed with the assessment of the majority. Where opinion was clearly divided, the respective percentages of respondents nominating different alternatives were provided and respondents asked to make a further assessment of their own position. Again written comments were invited, particularly where a panellist chose to differ from a majority position. Panellists were also asked to respond to new items introduced from responses to the first round.

Panellists were also asked to weight the different technologies against one another:

a) in relation to their relative importance in 1988
b) in relation to their expected relative importance in 1998
c) in relation to their desired relative importance in 1998.

They were asked to give the most important technology(ies) a weight of 100, those reckoned to be half as important a weight of 50 and so on (Roberts: 1976, ch.8)

Round 3 sought confirmation of the consensus (or polarisation) as defined by the summarised results of the Round 2 data. Final written comments were elicited and the importance weighting for Round 2 subjected to the review process.

Participants in Rounds 2 and 3 were asked whether the main sources of knowledge underlying their responses were based upon

1) first hand experience
2) professional literature
3) oral communication
4) popular literature
5) other.

Subsequently a frequency analysis was conducted to establish whether the responses that included (1) as a factor differed in any identifiable way from the rest of the participants. They did not.

The Panel

The characteristic Delphi panel is made up of respondents who have particular interest in, and/or expert knowledge of, the topic of the study. Ten potential categories of respondents were considered for the study:

1. Professional Educational Association Members
2. Business and Industry Leaders
3. Colleges of Advanced Education Staff
4. Curriculum Branches Staff
5. State Education Department Heads
6. University Staff
7. Members of the Federation of Scientific and Technological Societies
8. Participants in the Futures Conference, 1986
9. Politicians
10. Union Leaders

Two professional subject associations, mathematics and science, volunteered to canvass a wide cross-section of their members. These are the teacher groups which, on the whole, have had most to do with computer based technologies as well as the other technologies.

The categories include a blend of state education employers, teacher trainers, teacher practitioners, curriculum developers, and employers and teachers of secondary graduates with major interests both within and outside education. There was a nil response from politicians and unions, and a disappointing response from business. However, a good response was achieved overall with 141 replying to the first round and retention rates of 76% (107) and 87% (93) respectively between rounds.

Results

A high degree of consensus was achieved for most of the responses to questions about each of the technologies. There was also a consensus on the importance weights with most values clustering around the median. The narrow interquartile range (variation less than 5 from the median for 90% of the ratings) enables the median to provide a reliable measure of group weightings.

With respect to forecasting the future role (1998) of the technologies in education the following inferences may be drawn from the panel responses.

None of the traditional media will be obsolete, and **books, papers, and reference materials** will retain their position as the most important medium of instruction. Comments supporting this view included the need for the development of "good" textbooks, improvement in presentation and upgrading of libraries. Books were seen as still the most important media for learning, information and enjoyment. Contrasting views on the relative cost of books and electronic media appeared in the one year interval between the first and third rounds. Earlier comments indicated that the cost of technology is so high that books will not become obsolete, although two disagreed on the basis that new interactive technologies will become major "reference" sources, while a third felt the obsolescence of books would save trees. Comments a year later pointed to the rising cost of paper and printing together with the cheap and ready access to databases combined with the rapidly reducing cost of the technologies as leading to a reversal of the relative cost situation.

Blackboards and overhead projectors were seen as providing a somewhat reduced but still significant means of communication. There was a perceived need by a few participants to move from blackboard to whiteboard with high speed copiers to replace existing facilities. Improved technology will make overhead projectors more important, especially when used with LCDs - and this should alter whole group pedagogy. In contrast, however, several panellists responded that "old" and "traditional" teaching habits will remain, especially as increased class sizes will support reversion to "chalk and talk". In the third round several participants increased the weightings, pointing out that teachers are only just becoming fully aware of the advantages of the OHP as a teaching tool. Others, however, reduced weightings on the grounds that the rate of technological change is underestimated and OHPs supporting computer generated output will be in much greater use by 1998.

Live simulation and drama were judged to be of the same importance in 1998. Supporting comments saw these as stimulation to learning, providing for interactive exchanges with the possibility of leading to better communication skills. They were also seen as a valuable means of increasing problem solving skills, both social and educational and encouraging reflection and creativity. Some disagreed with the majority view that they would not lead to new kinds of learning, pointing out that new courses in dance and drama will lead to further developments in this area. Several pointed out that live acting out of situations should be emphasised as a humanising influence, and all strategies that increase the involvement of students in the learning process will increase in popularity.

Discussion in groups is the only item that was supported by all participants as being of the same or greater importance in 1998 for supporting instruction. It is seen as retaining its present level of importance in the hierarchy of instructional technologies as a medium whose removal would detract from the quality of education. The amount of group discussion is expected to increase by the majority of participants as it is an important social dimension in improving communication skills and interpersonal relationships which will become increasingly important as more student study/learning is computer/technology based and individualised. Many indicated that the introduction of more technology will lead to an even greater necessity to foster communication and discussion, and the demise of "chalk and talk" will see an increase in co-operative learning with increased demand for group activities.

The older audio-visual media such as **slides and filmstrips** will be much less important having been superseded by the more dynamic media of television, film and video. It was pointed out by several that although the equipment and presentation may change, educational usage of both audiotapes and slides is likely to remain the same and they may well keep their place for some time as they can be easily and readily produced by an individual.

These older media will be superseded by the more dynamic media of **television, film and video**. The use of these are seen as increasing in quantity although not in importance relative to the more highly rated technologies. While each provides an opportunity to bring reality to the classroom, to open up learning through experience, concern was expressed that too much use could lead to passive learning. Passive uses need to be replaced by interactive systems and by the third round several participants comments indicated that the use of video and interactive video is likely to increase especially with the recent increase in number and access to home video cameras and video cassette players. Others pointed out that the full potential of these media have not been reached as there are too few expert groups able to produce first class materials. They sought support for existing expert groups and the further development of these resources.

Computer assisted instruction was seen by the vast majority of participants as being of much greater importance in 1998, with the possibility of making new kinds of learning possible, enhancing education in general and being much more widely used. Although the weighting increased both in terms of expected and desired importance, it was still only weighted at 45. This weighting reflects the judgment that sufficient expertise does not currently exist in the teaching profession or in support services to make effective use of the full potential of CAI. It was seen as increasing capacity for learning, especially interactive learning, and valuable for simulating experiments and in investigations, problem solving and testing hypotheses. It was seen as particularly useful for teachers and students in remote areas, providing access to individualised learning and to subjects not otherwise available. Some saw an increase in the use of CAI as reflecting growing concern with how students learn rather than what they learn. Concern was also expressed that CAI, if not carefully controlled by educators, could become merely programmed learning used for economic rather than educational reasons. By the third round, one participant stated that technological change is underestimated and CAI is already of increased importance.

As with other computer based technologies, **databases** will increase in usage and importance, but not as much as is desirable. While databases are seen as providing greater access to (new) sources of information, encouraging research and the development of research skills, their effectiveness is still dependent on the quality of the data in the database and of the software to access it. Several participants pointed out the databases are probably best used in small groups where students can be encouraged to think and discuss an issue before framing a query for the database. Some felt that use of databases would increase, but not so much as a source of information in themselves as in the context of information systems. By Round 3 comments were being made that education has barely scratched the surface of this facility - that databases are likely to become the reference library of the information age, most likely as part of expert systems, but we currently do not have the technical facilities to use them now, neither are we likely to have them by 1998.

Although **interactive video** was seen as being in greater use, providing new ways of learning and making an important contribution to learning by 1998, its expected weighting was still fairly low. While it can provide access to experts, better teachers and more information, enabling discussion with people in remote areas, its cost is seen as prohibitive. That cost is not only seen in terms of the technical cost, but also in terms of the time required for preparation of all participants if the interaction is to be effective and the cost justifiable. As videodiscs become more readily available and accessible, interactive video with the interface controlled by computer software programs is likely to become a high growth area.

Satellite linking was also seen as too expensive still by 1998 to be a significant contributor to the education of the majority of students. It was seen as providing wider access to good quality materials and greater access to locally scarce skills. It is particularly useful for remote area students. It also allows the curriculum to be wider in small remote schools. This is already happening in some areas.

As might well be expected, the most important technology seen as having the most extensive and greatest impact on education by 1998 is the microcomputer. However, once again there was consensus that the expertise to develop its potential would not exist even by 1998. Hence there is a 10 point difference in weightings given to expected and desired importance as a medium of instruction. While comments indicated that most felt positively towards the future impact of the microcomputer on education in that it provides more power to the individual learner, opens up opportunities for mastery learning and access to a wider range of knowledge, its success depends on the quality of the software. Some were not so enthusiastic, stating that computers could never be better or cheaper than group interaction, that computers have a place, but it is as supporting learning, not directing it. While the technology is improving, there is still a limit to what it can do.

While home computers were rated as fairly important for 1998 their removal (or lack of access) will not detract from the quality of education. Hence a radical change to the institution of schooling is not envisaged in that effective education will continue to be provided using resources outside the home.

The more exotic technologies such as video disc, tele-conferencing, compact disc, English input authoring languages and holograph technology, which were introduced from round 1 received so little support from the panel that they were dropped from the final round. While cost, access and availability might have eliminated the others, by the end of 1988, compact discs were becoming more readily available, especially in the music world, and by the end of 1990 the response to this item might well have been very different.

While blackboards, books and group discussion clearly suggest a continuation of traditional teacher roles, the predicted importance of the new technologies point to a greater emphasis on small group and individual learning modes. This change in emphasis has implications for pre - and inservice teacher education as much as for teaching at all levels of tertiary education.

While the panel saw the use of computer based technologies as making new kinds of learning possible and could well enhance the quality of education beyond the present level, it was strongly convinced that the expertise necessary to develop the potential of these technologies does not at present lie within the teaching profession. This is equally true of staff in tertiary institutions. The clear implication is that specialised assistance needs to be recruited by education authorities if the potential of the computer based information technologies is to be developed and realised. It will not be achieved by supplying hardware and quick courses on methods of use to busy teachers. Further, the indication is that it will be better to select and develop two or three technologies to their full potential rather than spread effort more thinly over a more exotic range.

These views were confirmed by responses to the three specialist questionnaires on literacy, numeracy and scientific knowledge. Each group of panellists effectively defined levels of basic knowledge and skill in their respective domains at much higher cognitive levels than currently perceived, or could be expected in ten years' time.

The discrepancies between the expected and desired uses of technology in 1998 suggest that the panellists are not optimistic that sufficient support will be provided to fulfil the potential of the information technologies with respect to education. The commitment and resources required to support the developments foreshadowed in "An Apple for the Teacher" should not be underestimated given that they are accepted as desirable by this representative group.

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SEATS : THE AUSTRALIAN STOCK EXCHANGE'S TRANSITION FROM CHALKBOARD TO KEYBOARD

by

Julie M Cashin

ABSTRACT

The revolution in the Australian stockbroking industry brought about by the introduction of screen trading (known as SEATS) in 1987, eventually led to the closure of all Trading Floors within Australia on September 28 of this year. SEATS is acknowledged as the most advanced trading system in the world in that it is fully automated. That is, the execution of the trade is carried out by the system which matches "bids" and "offers", not merely recording them, as is the case with most overseas systems. The trading terminals are used to watch the market in selected stocks, to enter bids and offers for automatic execution, to monitor any outstanding bids and offers and adjust them where necessary.

This paper examines the human element and relates the implications for training personnel, in re-educating an entire industry steeped in over 100 years of tradition, and providing "hands-on" skills training, to ensure the successful implementation of the system.

SEATS : THE AUSTRALIAN STOCK EXCHANGE'S TRANSITION FROM CHALKBOARD TO KEYBOARD

by

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INTRODUCTION

All trading in equity securities on the Australian Stock Exchange (ASX) is now conducted through SEATS, which is the acronym for "STOCK EXCHANGE AUTOMATED TRADING SYSTEM".

After the close of trading on Friday, 28 September, 1990, all trading floors in Australia's six state capital cities were closed. We now have one National Stockmarket in Australia which allows stockbrokers throughout the country to see the depth of the market and provides for the quick execution of orders on a cost-effective basis. This major development allows for a more unified market which will be viewed favourably by local and overseas investors and market participants.

Whilst adding a lively new dimension to trading in Australian shares, with prices and transactions instantly visible on the screen, the introduction of SEATS has had major repercussions on the training and education of stockbroking personnel and all allied groups.

These pages give an historical perspective to the issues addressed in the introduction of screen trading. The conference presentation will focus more closely on the functionality of the system and the implications of re-training the Australian stockbroking industry participants in preparation for the new technology, and will include a visual simulation of a SEATS screen display.

THE ROLE OF THE STOCK EXCHANGE IN FINANCIAL MARKETS

Australian stockmarket activity began in 1828 with the 1850 gold rush spurring on the development of Exchange centres. Towards the end of the 19th century, exchanges had been established in Adelaide, Brisbane, Hobart, Melbourne, Perth and Sydney.

The markets developed for two major reasons:

1. A company's need for additional funds; and

2. An individual's need to invest surplus money.

Essentially it is the role of the Stock Exchange to provide an open market where the shares and securities of companies and the securities of government and semi-government authorities can be bought and sold. An active and progressive stockmarket fosters enterprise.

The Australian Stock Exchange is a dynamic institution, providing investors and listed companies with a steady stream of innovative products and services; increasingly this is being achieved through the application of computer technology.

DE-REGULATION AND FORMATION OF ASX

Against an unprecedented boom in share prices in the 1980's, the Australian stockbroking industry as one part of the financial system underwent a process of de-regulation, bringing with it the introduction of negotiated rates of brokerage, and the opening up of the ownership of local stockbroking firms to foreigners and non-broking entities. Furthermore, the proposal to merge the six state Stock Exchanges into one was accepted by Members of all exchanges in December 1985. This led to the emergence in April 1987 of the Australian Stock Exchange and a pooling of all resources to meet the many challenges being faced by the industry.

In essence the formation of the ASX was a landmark decision which provided the means by which one national market could be facilitated, that took Australian equity markets to the world forefront of commerce and efficiency. No other country with comparable geography has attempted such a link.

HOW DID THE AUSTRALIAN STOCK EXCHANGE COME TO ADOPT COMPUTER TECHNOLOGY FOR ITS STOCKMARKET?

Throughout the Exchanges' history there have been only 3 trading systems used, namely:-

"Call Room Trading" which operated until 1960/61

"Floor Trading" from 1960/61 until September, 1990, and

"Screen Based Trading" from 19 October, 1987.

In contrast with many overseas Exchanges which provide "quote driven" markets with market makers or specialists continuously making two-way deals, the stockmarkets in Australia have always been "order driven" where buy and sell orders are advertised to the market and a trade results when there is a match.

The significance of the evolution of SEATS may be better understood by first examining the 2 earlier trading systems:

Call Room Trading

Call Room trading may be likened to an auction, where the securities of listed companies were "called" once or twice daily and any stockbroking firm with orders in that security would quickly state their bid or offer to the Reader whose task it was to match the buying and selling orders at identical prices and call the sales that had been transacted. The system, whilst it had its limitations was quite effective, until the list of companies became too long for the amount of time available.

Floor Trading

By 1960, Australian stockbrokers were looking for a better method of trading which would provide for continuous trading in quoted securities. Floor Trading was selected to provide continuous trading.

The system designed for Floor Trading basically remained in place until 28 September, 1990. Under this method, quoted securities were displayed on Posts which were chalk boards around the walls of the trading floor. The Posts were serviced by Exchange employees known as "Chalkies".

Once the Posts were opened for trading, the stockbrokers' employees known as "Operators" stood in front of the post where the securities on which they wished to trade were listed and announced their bids and offers in a loud and audible voice. The "Chalkies" recorded these bids and offers on the Posts. As sales took place between two operators, the price details were called by the buyer to the Chalkies who recorded the price.

SCREEN BASED TRADING

In December 1986 the Members of the six Australian Stock Exchanges voted in favour of the introduction of the Stock Exchange Automated Trading System - SEATS - Stage 1.

There are 5 reasons why this decision was taken:-

1. There was a strong trend for the introduction of automated trading systems in most Stock Exchanges around the world. At that time many had introduced a high degree of automation for smaller transactions;

2. Such systems were based on increasing the efficiency of trading and a reduction in execution times and costs;

3. Competitive markets based on some of the present market information services were developing around the world;

4. There was a need to attract international dealing in Australian securities back to Australia;

5. There was continued pressure from the Regulatory Bodies in Australia for greater market efficiency and improved investor protection in order to ensure that our market was fair and equitable and subject to ready surveillance whenever necessary.

Screen Based Trading makes use of computer technology which enables stockbrokers anywhere in Australia, through terminals located in their offices, to observe the market, to record their buy and sell orders in the system (which then automatically "marries" bids and offers which match), and to trade securities at the push of a button.

A Consultant was engaged to advise the Stock Exchange on the technical aspects of a suitable trading system. The Exchange selected Digital Equipment Corporation as its computer hardware supplier with the system being built around DEC-VAX. Trading terminals were NEC 286 PC's. The software was written by outside contractors.

A staged development was recommended with Trading commencing in a few securities to enable the Exchange to test the computer system and be satisfied that the Trading Rules used were suitable.

On 19 October 1987, the ASX commenced SEATS trading in the securities of 20 companies which were actively traded.

Initially trading was limited to Melbourne and Sydney stockbrokers, and for the stocks traded on SEATS there was no facility for trading the companies' securities on the trading floor of Melbourne and Sydney.

After ensuring that SEATS was functioning according to the specification and that brokers had become familiar with the system, on 27 January 1988, the ASX added the securities of another 10 industrial companies which were less active. On 1 March 1988 Brisbane stockbrokers were included, followed on 14 March 1988 by Perth stockbrokers, 28 March by Hobart and on 11 April, Adelaide, making the system the national market for those securities traded on SEATS.

As securities were transferred to SEATS, trading in those securities was not permitted on any trading floor. Blocks of companies were progressively added to SEATS through to 10 July, 1989.

Dual Trading

The next decision to be made by the ASX was whether or not to keep the trading floors open. SEATS had been an outstanding success. It had proven itself to be cost effective in respect of the more lightly traded stocks and had demonstrated its ability to handle large volumes of trading in the more active stocks. However, there was significant debate amongst the brokers throughout Australia as to whether it was the better system for large trades in the more active stocks. The issue was further clouded by the fact that the Exchange centres outside Melbourne and Sydney were too small to justify the continuation of trading floors and brokers in those centres felt disadvantaged because some major stocks were not traded on SEATS.

Hence, in the period October 1987 to September 1990, the ASX monitored 2 order driven market systems for equities:-

1. The Trading Floors - Where the best buy and sell quotes derived from orders were displayed on boards and were changed by floor traders' open outcry.

2. The Computer Order Display system (SEATS) - Where the matching of orders automatically results in a trade.

The trading floors were essentially tied to a particular location, whilst SEATS is a totally national system.

Then, to resolve the issue of "SEATS vs The Trading Floor", the ASX Board decided on a further trial from 3 September. The equity securities of the most 100 actively traded securities were classified as "Alpha" securities. All other equity securities were classified as "Beta" securities. All Equity Securities were listed for trading in SEATS, except orders in Alpha Securities above $25,000 which could be traded on the Brisbane, Melbourne and Sydney trading floors. (The floors in Adelaide, Hobart and Perth were closed.)

It was considered that this trial would allow the relative merits of SEATS and the Trading Floor - for large trades in the more active stocks - to be determined empirically by the action of competing brokers.

Within the first few days of the trial, a number of stockbrokers reported that they did not like the trial as it was more difficult to obtain a feel of where volume could be executed. It was necessary for them to watch the market's price dissemination services covering Melbourne, Sydney and SEATS markets.

By taking the smaller orders away from the trading floor, liquidity on the floor was affected and it was interesting to note that on the first few days of this trial, operators on the trading floor gathered around SEATS terminals to see the opening prices of Securities on SEATS before wanting to do business on the trading floors.

At its meeting on 25 September, 1990, the ASX Board after considering the results of the dual trial during September and the reaction of the Members and other participants, resolved to close the trading floors as from the close of trading on Friday, 28 September, 1990.

The net result of the Board's decision, is that all stockbrokers regardless of their location, have equal access to Australia's stockmarket with the advantages of greater liquidity provided by SEATS. Contrast this facility, to that where brokers previously were limited geographically to the market in their city, or had access to interstate markets through agents (at a cost) when their market for a particular security was not liquid.

TRADING RULES

The Trading Rules for SEATS were developed in consultation with Members and incorporated some different principles. Since SEATS was first introduced the ASX has amended a number of the Trading Rules with the approval of the National Companies and Securities Commission. This experimentation with the Rules has been necessary to ensure that we maintain the most efficient system for Australia.

The trading principles which called for an intensive re-training process included:

The principle of priority trading
The opening procedure
The level of disclosure of stock for sale or purchase
New crossing rules

The implications of these rule developments for the re-training of authorised trading floor operators shall be dealt with in greater detail during the presentation.

THE TRAINING OF AUTHORISED OPERATORS

Managing the "human" element, on which the success of the operation so greatly depended was an enormous task left to the ASX's Training and Development department to co-ordinate, administer and deliver.

The challenge lay in understanding every aspect of the Post-Trading process in operation on Australia's 6 trading floors, and conceptualising a training programme that would translate these techniques to the mechanism of trading on a screen.

Training for authorised trading floor operators began in April 1987 at the height of the bull market, in preparation for the introduction of SEATS later that year.

In the two largest sites - Melbourne and Sydney - where the numbers of trainees were in excess of 1,000, training was conducted at the Stock Exchange premises in fully equipped computerised training rooms. Here a simulated live market was utilised in an intensive hands-on series of sessions, conducted by ASX Training and Development personnel.

The PHAB (Perth, Hobart, Adelaide and Brisbane) brokers were trained the following year on a training database which ran independently of the live market where the trainees were assisted by training personnel.

The skill and knowledge transfer for existing operators in each state took the form of overview sessions and workshops, and was tested in a national competition conducted after-hours prior to conversion to the "live" market.

The flow-through of information in a stockbroker's office is such that the introduction of SEATS had repercussions "down the line" in the various departments within each firm. Hence, sessions providing a basic understanding of the system were conducted for Dealers, Institutional and Private Client Advisors, Research personnel and support staff.

Furthermore, the establishment of a national Help Desk and the training of suitable personnel to operate the facility was a necessary part of the overall training plan. The development of programmes to educate financial journalists (print and electronic media), executives of Listed Companies and visiting dignitaries from Australia and overseas were also conducted to complete the re-education process in the industry.

The Outcome

The success of the pre-implementation training programmes was evidenced in the months post-implementation, where the number of enquiries and errors could be monitored by Help Desk personnel in the Market Control Area, and where brokers' skills were tested in a post-crash environment.

In a relatively short period of time, SEATS has transformed the industry and has spurred on the development of further technology to speed up the settlement of trades and the transfer of documents between buyers, sellers and listed companies. Such developments will see Australia position itself even more favourably in the global securities market.

INTRODUCING TEACHING TECHNOLOGY AT TERTIARY LEVEL
A PARTICIPANT CASE STUDY

by

Debbie Clayton, John Dekkers, Phillip Farrands
Shirley Gregor, Graham Pegg, Lynn Zelmer

ABSTRACT

Whilst most tertiary institutions are cognizant of the potential of teaching technologies such as Computer Managed Learning (CML) for educational management and efficient student assessment, few have adopted a coordinated campus-wide approach to its introduction. Reasons identified include:

- the high establishment cost of infrastructure to support this technology
- the lack of documented cost/benefit analyses of such wide scale adoption
- some educators' and administrators' philosophical stance and attitudes on the use of computer-based teaching technologies
- the difficulty of obtaining campus-wide agreement on an implementation model, and
- the associated issues of standardizing on development and delivery software and hardware for the CML system

Problems are exacerbated when the implementation must include delivery to students studying on-campus, at branch campuses (in towns away from the main campus) and at a distance.

This paper provides a case study discussion of the process adopted by a Working Party established to advise on the wide-scale introduction of CML at a tertiary institution. It details this process from the initial working brief to the University's Academic Board's final acceptance, in principle, of the Working Party's recommendations.

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Introduction

The discontinuance of the binary system in higher education (Dawkins, 1987), required Colleges of Advanced Education such as Capricornia Institute (now the University College of Central Queensland, UCCQ) to adopt a profile that contained an increased emphasis on postgraduate course offerings and research output. To date, however, there has been no real increase in funding to assist these major changes in direction.

With this changing emphasis towards research and postgraduate based activities, institutions such as UCCQ have begun to seriously consider mechanisms to provide staff with the necessary time and funds so that they could pursue these activities. One such mechanism is to improve teaching efficiency and effectiveness. Teaching technologies such as CML were perceived as having the potential to achieve this.

Tertiary institutions in Queensland and elsewhere in Australia, have successfully utilized CML for educational management and efficient student assessment (Carss, 1987; Crock and Timmins, 1988; Stanford and Cook, 1987a). In the past, UCCQ had successfully utilized CML in some subjects, notably the P-Maths CML system (Clayton and Smith, 1984) for the administration of a continuing education bridging mathematics course. However the UCCQ senior management sought to determine the efficacy of wide-scale introduction of CML at the University.

In April 1989 the UCCQ Vice Chancellor established a Working Party on CML, hereafter referred to as the Working Party, comprised of the authors to advise on this proposed introduction of CML. The Working Party's brief was:

- to determine whether or not there should be a wide scale introduction of CML, and if so
- the academic, financial, and equipment implications of the preferred CML system,
- to determine the development pathway for CML introduction,
- to review existing commercial and institution generated CML systems,
- to determine the feasibility of developing an in-house CML system, and
- to determine how to advise staff seeking to change methodologies from a teaching-based system to a student learning-based system.

Answering the Brief

Taking a systems analyst's perspective to introducing any new computer based system, the Working Party adopted an investigative model that firstly defined the aims and scope of the project. Next, initial information on user requirements, basic resource requirements, constraints, possible solutions and some idea of projected costs and benefits were determined. Then recommendations on how to proceed to the next stage were then provided to management for their consideration.

Users Needs

For a brief such as the above an approach to use is to hire an external consultant. This would require as a first step for the external consultant to become familiar with the operations of our institution prior to performing a needs analysis. Instead the approach taken was for the Working Party members to serve as consultants. The Working Party had the advantage of already having some of this knowledge, however to fully specify users' needs, a series of "public" meetings were called at the University to provide information to identified groups of CML users and to gather information from these groups. Separate meetings were held for:

- academic staff,
- deans and heads of departments,
- students, and
- administrative staff.

Staff and students were also invited to provide written submissions concerning their views on and needs for CML.

The outcomes of these meetings were, on the whole, quite positive, with academic staff responsible for large classes keen to receive, at the very least, some automated marking assistance. However, there was comparatively little interest expressed in more complex CML systems in which automatic marking is integrated with the updating of the Students' Records system. This was interpreted by the Working Party as due to lack of imagination, caution or unfamiliarity with the concept.

Concerns expressed by academic staff in using CML included: test banks were often limited to multiple choice questions (some staff were simply philosophically opposed to using this form of assessment); possible problems with cheating and security; increased hardware requirements; uncertainty as to whether time would actually be saved; impersonalisation and the effect on the flexibility of the teaching/learning process; and the cost of implementation.

Staff who had previously been involved in CAL projects on campus considered that funding support was needed before they were prepared to be involved in any further computer-based teaching technologies. The following comment reflected this view.

> "I was initially enthusiastic about using computers in my Biology teaching and helped to get the first set of multiple choice questions onto the Apples in the study centres. I subsequently had my enthusiasm sapped because of a series of difficulties....
>
> We have to develop a total CML environment. We seem to get software without hardware or visa-versa. I could be enthused again if:
>
> - My students could get ready and easy access to hardware....
> - There was a suitable authoring environment....
> - There was some support (relief) and recognition for staff prepared to be involved" (Newby, 1989).

Students implicated cautious interest in CML, in particular with regard to the flexibility it might allow for self-paced tests and working at home as reflected in the following comment.

> "Sometimes you feel stifled by some people (students) who are going slower than you. With a computer you can go through the work yourself" (UCCQ Student, 1989).

Some students, however, were concerned that there might be a negative effect of reduced face-to-face contact with staff.

Development and Delivery Needs

In its preliminary brief the Working Party examined CML systems used elsewhere and in the process identified system parameters that needed to be taken into consideration in the selection of an appropriate CML system for UCCQ. It was seen by the Working Party that the system needed to

- interface with the existing Students' Records system resident on an HP4800,
- operate at various levels of sophistication, from a simple level of administering and marking one or two semester tests, to a full system which completely managed a subject including advising students of learning objectives, directing students to learning resources and activities, and administering and marking both formative and summative assessment tests,
- include test bank authoring facilities that would allow for creation of not only text based questions but also those containing graphics and complex mathematical and scientific formulae.

Furthermore, the system to be adopted would need to be able to be accessed by on-campus students, students studying at branch campuses at Bundaberg, Mackay, Emerald and Gladstone, and by distance education students.

Report Recommendations

In October 1989 the Working Party presented the final report to the Vice Chancellor (Clayton et al, 1989). The report concluded that CML, in general, provided a powerful mechanism for addressing such issues as the utilization of human resources particularly regarding the release of academic staff from administrative teaching chores, support to students studying in both on-campus and in distance learning modes, increasing learning effectiveness and the testing and administration of subjects with large (greater than 100) student numbers. It recommended that UCCQ should:

"- adopt CML as a component of its administration and instruction in suitable subject areas where clearly defined benefits were anticipated, and

- allocate funds to support such an adoption"

(Clayton et al, 1989, p1).

Development Pathway

Tertiary institutions, in particular the Queensland University of Technology (Ellis, 1989) and the University College of Southern Queensland (Division of External and Continuing Education, 1986) have clearly demonstrated the success of the centralised CML model. The Working Party argued on the following premises that this approach would:

- provide a focus for and economise on CML development,
- ensure a continuity of staff efforts so that when staff leave and government funded projects terminate, CML project work commenced is not abandoned,

- ensure that CML support infrastructures are not duplicated, and

- enable all academic teaching areas, not just those that were the technologically "elite", to benefit from this form of technology-based teaching.

UCCQ has the advantage of being a relatively small institution and had already demonstrated a co-operative spirit to computer-based teaching technologies through the activities of a Computers and Learning Interest Group.

Thus the proposed development pathway for the implementation of CML was to:

- adopt a centralized model for a coordinated approach to the implementation of CML. To do this the University needed to develop an infrastructure by establishing a CML unit to act as a focus for, and a coordinator of, CML implementation and development. It was proposed that the unit would be staffed, in the first instance, by a coordinator who would be responsible for the establishment and implementation of a centralised CML system. The coordinator would also be in charge of programmers coding subjects into the CML system and would liaise with a CML development officer from each School. The development officers would support and advise academic staff whose subjects were being put on the CML system.

- proceed with the use of a commercial CML system. Given the experience of other tertiary institutions, the Working Party recommended that commercial CML authoring software be purchased rather than developed in house. Given access considerations for staff and students, on-campus at branch campuses and at a distance, it appeared appropriate that the CML system should be microcomputer based and preferably using IBM/MS-DOS compatible microcomputers with the facility to upload/download to the Students' Records system.

- commence pilot projects. Several Schools had identified appropriate projects and had indicated willingness to be involved in such projects.

Costings

The report was accompanied by a provisional budget for a three year pilot involving all six Schools. This budget is summarised in Table 1.

The setup software costs comprised $45,000 for the purchase of commercial CML authoring software and $30,000 for programmers' salaries (excluding on-costs) for creating the software links to the Students' Records System. CML staff salaries comprised the salary of a fulltime coordinator and six-half time programmers who would code the CML subjects for the six Schools. The salaries of academic staff involved in developing CML subjects were not included as this was perceived to be a School supported cost.

Table 1.

Budget for Establishment of a CML Unit

Setup Costs		
CML Authoring Software		$45,000
Software links Students' Records System		$30,000
Development Hardware		$38,000
Microcomputer Laboratory		$78,000
	Total	$191,000
Recurrent Yearly Costs		
CML Staff Salaries		$113,000
Software Maintenance		$13,500
Hardware Maintenance/Replacement		$29,000
	Total	$155,500

Few routine computing systems operating in business stand up favourably to a detailed cost/benefit analysis (Bingham and Davies, 1972). The Working Party report did not attempt to provide a detailed cost/benefit analysis of the use of CML nor to cost CML as a separate teaching activity. Indeed UCCQ has never budgeted individual teaching activities in order to determine the cost effectiveness of a teaching technique. Cost/benefit scenarios were drawn from past experience of the Working Party members (Clayton and Smith, 1984; Zelmer, 1989) and based upon CML implementations at the University of Queensland (Stanford and Cook, 1987b) and at the University College of Southern Queensland (Crock and Timmins, 1988). The Working Party was cautious in paralleling the costs of teaching activities at UCCQ to the costs at other institutions with different funding arrangements.

Consideration of the Working Party's Report

Whilst, at senior management level, there was general support that CML could assist teaching effectiveness and efficiency, no decision was made initially to adopt the recommendations of the Working Party when they were presented. In retrospect, this was basically due to:

- the perceived "excessive" cost of establishing the CML infrastructure and the yearly support costs as "hard" costing data was lacking,
- some members of the senior management structure did not agree with the centralised model of a coordinated approach, preferring School-based projects, and
- the reluctance of the Working Party to provide a detailed costing of CML teaching versus other forms of teaching.

During the period November 1989 to July 1990, a number of meetings were held between senior management and the Working Party concerning clarification on aspects of the report and considering additional information on the use of CML.

Significant events in that period included:

- Whilst not adopting the Working Party's recommendations, senior management sought expressions of interest from members of the Working Party to be seconded as the coordinator on a half-time basis. The Working Party argued strongly for the appointment of a full-time coordinator, so that person could devote their entire energies to the task and also operate independently from "loyalty to School" constraints. No member of the Working Party was interested in a full-time secondment.

- Some Schools felt they could not wait for senior management to accept and implement the Working Party's recommendations. For example, the School of Health Science had commenced a DEET funded CAL/CML project, and needed to make immediate decisions on software and hardware delivery systems.

- The School of Business commenced using paper-based multiple choice tests marked by an Optical Mark Reader purchased jointly by the Schools of Business, Science and Health Science.

- Initially, senior management decided that a pilot involving all six Schools was too costly and requested the budget for a pilot limited to two Schools. This was broadened to include three Schools, on the request of the School of Health Science as they were already undertaking a CAL/CML project. The budget was revised to include three Schools.

- As expected, the decision as to which Schools should be "in" the pilot was a controversial one. The Working Party recommended that, for a meaningful trial testing all facets of the development and delivery system, Schools involved should teach large classes on campus, at branch campuses and in distance mode, and have test banks that were text and graphics based and involve complex scientific and mathematical formulae.

- The Working Party provided senior management with an action plan for the six semesters of the pilot. This included setting time lines for establishing the CML support infrastructure and subject development. Detailed resource requirements and the pilot "system capacity" in terms of potential number of subjects that could be developed and implemented were determined.

- Because of the potential costs (which would need to be drawn from the top of the School's budgets), both for a reasonable pilot and for the long term, the Vice Chancellor's Committee requested that the Working Party summarize their report and associated documentation for submission to the Academic Board for their consideration. The Vice Chancellor's Committee wanted support from the whole academic community before proceeding with the Working Party's recommendations.

During this period the campus staff were kept informed of the progress made by the Working Party through several public meetings held at UCCQ.

Adoption of Recommendations

In August 1990 the Working Party submitted a proposal to the Academic Board which recommended that a CML pilot project be funded for an initial period of three years in order to demonstrate that using CML could improve the efficiency and effectiveness of teaching and to provide a basis for a coordinated approach to CML at UCCQ.

The Working Party did not feel at all confident that the Academic Board would support its recommendations, mainly because it required a significant funding commitment for a number of years without the guarantee that there would be a real cost/benefit savings. However, extensive lobbying in all Schools and Service Units prior to the Academic Board meeting did seem to indicate general support for the proposal.

The Working Party were concerned that taking such an involved proposal to such a large forum would result in it being referred to, and buried in, the University's committee structures with the possibility that a decision would be delayed indefinitely. However, after much debate on the cost of the pilot and who should/wished to be in the pilot the Academic Board supported, in principle, the Working Party's recommendations and indicated that this support should be conveyed to the Vice Chancellor's Committee.

In view of Academic Board's response to the proposal, the Vice Chancellor's Committee then sought advice from the University's Operations Grants Committee on how to proceed to fund the project. The implementation phase had finally been reached!

A Postmortem

It is of interest to reflect on the process outlined, and in doing so hopefully provide guidance for other institutions about to embark on a similar exercise.

Use of Existing Staff as Consultants

There are advantages and disadvantages of using the expertise of staff within an organisation to advise management on the wide scale introduction of technology-based teaching. From management's point of view, internal consultants are cheap, as these staff are already salaried, and they already know the organisation's operations and structure. Internal consultants may need to work to longer time lines as they are doing the consultancy on top of normal duties. As their time is not being costed, repeated requests for further information, and to restructure recommendations and proposals can be made. The Working Party was prepared to meet these demands as it was convinced of the merits of its recommendations.

Whilst the cost of an external consultant is an up-front cost that must be met by management, organisations sometimes place (whether rightly or wrongly), more credence on "outside" advice. Perhaps there is also more commitment by management to the more timely adoption of an external consultant's recommendations, as they have "paid" for this advice.

Information Provision and Dissemination

Early in the investigation process, it became apparent to the Working Party that few academics really knew what CML was. Several academics confused CML with CAL. In retrospect, a prototype CML system that could be demonstrated to both academic staff and management would have been extremely valuable.

Whilst information was gained and disseminated at the "public" meetings, and Working Party members had lobbied most of the academic board representatives from each School and Service Unit, some members of the Academic Board and senior staff still argued that they were not aware of the background and previous extensive consultation that had preceded the proposal to that Board. This could have perhaps been averted by the Working Party attending the Board of Studies Meetings for each School, prior to the proposal being put to Academic Board, and further explaining their recommendations. Although this would have been an extremely time consuming exercise, the Working Party consider, in hindsight it would have been time well spent.

Information dissemination was not assisted by senior management.

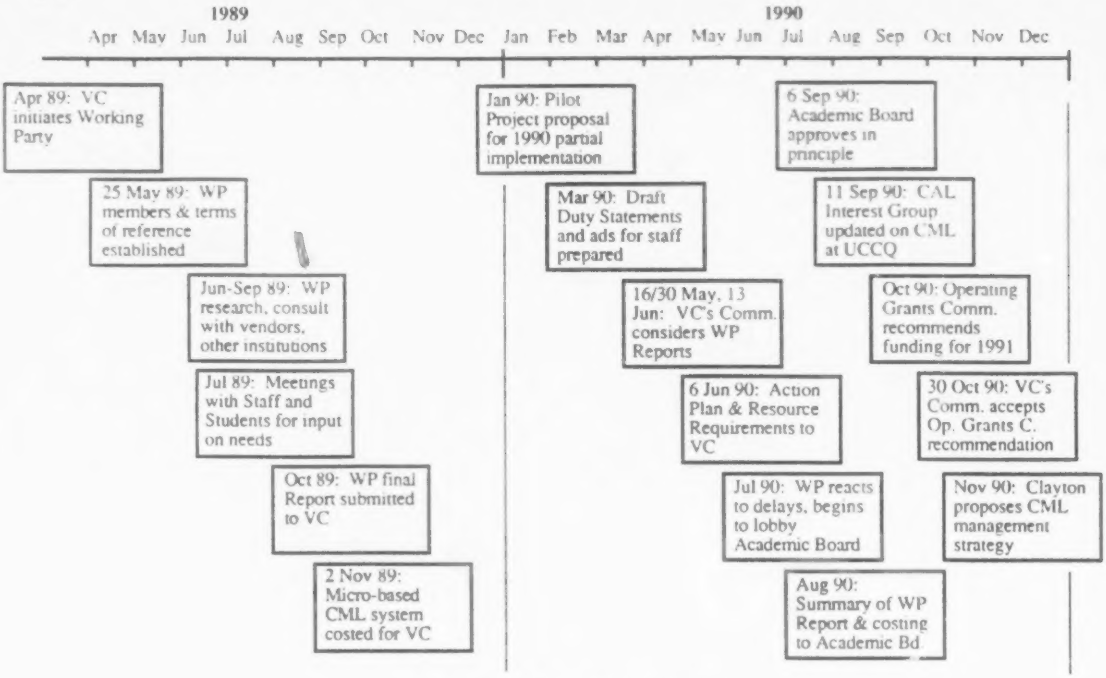
"The Working Party recommends that the information contained in this Report be widely disseminated, for example, to the Academic Staff Association, to the Student Union, and to the Institute's Management Advisory Committee" (Clayton et al, 1989, p 2).

Contrary to this recommendation, the initial report was not widely distributed. In this regard, the Working Party itself should have widely circulated a summary of the report to all academic staff.

Delays

The Working Party considered that an inordinate amount of time elapsed from when the report was initially presented to senior management to when a decision was made on implementation. This can be more clearly seen in the time-line in Figure 1.

Perhaps an equal amount of time will elapse before subjects using CML are actually developed and implemented. Are these time lines on decision making usual for institutions such as UCCQ or do they reflect senior management styles? It is likely that these delays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Apr 89: VC initiates Working Party
25 May 89: WP members & terms of reference established
Jun-Sep 89: WP research, consult with vendors, other institutions
Jul 89: Meetings with Staff and Students for input on needs
Oct 89: WP final Report submitted to VC
2 Nov 89: Micro-based CML system costed for VC
Jan 90: Pilot Project proposal for 1990 partial implementation
Mar 90: Draft Duty Statements and ads for staff prepared
16/30 May, 13 Jun: VC's Comm. considers WP Reports
6 Jun 90: Action Plan & Resource Requirements to VC
Jul 90: WP reacts to delays, begins to lobby Academic Board
Aug 90: Summary of WP Report & costing to Academic Bd
6 Sep 90: Academic Board approves in principle
11 Sep 90: CAL Interest Group updated on CML at UCCQ
Oct 90: Operating Grants Comm. recommends funding for 1991
30 Oct 90: VC's Comm. accepts Op. Grants C. recommendation
Nov 90: Clayton proposes CML management strategy

Figure 1: UCCQ CML Timeline

did cause problems as some new staff on the Academic Board claimed that they were unfamiliar with the background to the CML proposal.

CML Costs and Benefits

The Working Party found that virtually no detailed information existed comparing (in a tertiary environment such as UCCQ) the costs of using traditional teaching methods to the wide-scale use of CML based methods.

Whilst there was general agreement on the Vice Chancellor's Committee that CML could improve the quality of a student's educational experience, some members failed to be convinced that CML was cost effective. This was the issue that proved most difficult for the Working Party, as they did not feel at all confident that they could accurately quantify the cost savings. Although cost saving scenarios were presented, failure to quote a firm figure as a cost saving of CML over traditional teaching methods certainly was detrimental to the progress of Working Party recommendations being adopted. Cynically, one could argue that senior management is much happier with detailed but possibly inaccurate average cost estimates, rather than less detailed more accurate estimates. Even more cynically, the real costs of this lengthy feasibility phase for CML introduction no doubt exceed the budgeted costs for the pilot implementation!

Concluding Comments

At the time of writing, the Working Party has now completed the process of advising on the wide-scale introduction of CML at UCCQ. The next phase in this process is for a new, more widely representative, coordinating committee to be established to implement the Working Party's recommendations. Despite the considerable time commitment involved and the frustrations experienced by the Working Party members during the past 20 months, it is envisaged that most will be keen to be involved with the implementation phase!

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POWER, POLITICS AND PATRONAGE
THE EVOLUTION OF AN ADULT EDUCATION RESOURCE CENTRE

by

Ross Dickinson
and
Peter Kandlbinder

ABSTRACT

This paper traces the development of an educational resource unit for the Faculty of Adult Education at UTS. It also reflects the change of the faculty's equation from resources equals library into the acceptance of a multimedia open access resource unit to support practitioners of adult learning and teaching which in this faculty, means both its staff and students.

The Centre provides the kinds of equipment which such practitioners may need, and offers advice in the design, selection and use of educational media. It provides for the capture and manipulation of sound, moving images, photographs, 3D models and text both computer generated or by traditional means.

It is an aim of the Unit to promote a climate which encourages the development of co-operation between and among practitioners and to serve the wider adult education community, particularly the more poorly resourced sections of that community by providing a space where practising adult educators can meet and exchange ideas.

The paper stresses the importance of maintaining the human aspects of information technology while providing access to and training in the use of technological aids to training and learning.

POWER, POLITICS AND PATRONAGE THE EVOLUTION OF AN ADULT EDUCATION RESOURCE CENTRE

by

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and

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The purpose of the Faculty of Adult Education of the University of Technology is to provide teacher training to people who teach adults. The awards offered range from a Diploma of Teaching to Master, with a Doctorate being offered in the near future. A significant number of our clients are TAFE teachers - plumbers, carpenters, word processors, engineers, accountants, interior decorators etc. Other clients include industrial and commercial trainers, TESOL teachers, community educators and Aboriginal educators.

The Faculty began life in the 40's as a part of Sydney Teachers College, known as the Technical Teacher Education Annexe. In 1982, when co-author Ross Dickinson joined it, it attained the ponderous title of the Institute of Technical and Adult Teacher Education (ITATE - as some of the veterans still affectionately call it) as part of the amalgamation of metropolitan teacher's colleges that became Sydney college of Advance Education.

Between 1982 - 1989 a remarkable library service was developed by a dedicated, determined and rather aggressively self advertising team under one Virginia Costello. The old TTE library, a collection of unused, obsolete textbooks, became the best library collection of adult education (including books, journals and A/V material) in

Australia, while the TESOL collection had a reputation for quality that caused overseas scholars to visit, and the annual loans figure rose from 3000 per year in 1981 to 30000 in 1989.

In 1989 the second generation of amalgamations occurred, and ITATE was absorbed into the University of Technology, Sydney (UTS) from January 1, 1990. A rather telling reason for this option to be selected was the fact we already 'occupied a wing of UTS' Haymarket Campus, thus requiring an absolute minimum of physical movement. 1989 was a year of 2 absorbing struggles. One of these was amusing: a series of amazingly impassioned meetings to determine the name of the new Faculty. The other, in which co-author Dickinson was intimately involved, was concerned with what to do with the library. After almost a year of meetings (ranging in quality from reasoned debate to intemperate argument) it was decided to absorb the ex-ITATE collection into the central UTS Library service. The various rationales for this ranged from the pragmatic (eg the overall lack of space throughout UTS) to political (no other Faculty has its own library so why should we?). Thus in January 1990 the library material, shelving and most of the furniture - were physically moved into the UTS Library, along with those of the staff who hadn't accepted voluntary redundancy. Except for two.

Ross Dickinson (who is having difficulty writing about himself in the third person - unlike Julius Caesar) had acquired a reputation in ITATE for energy, enthusiasm and commitment to the needs of the place's staff and students. He was asked by senior staff in late 1989 to remain with the new faculty to set up a centre to provide resources for practitioners of adult education. Because he had the above qualities and also had previously spent several years in large university libraries, he accepted with aclarity, along with a clerk typist from the old library staff as an assistant. 1990 looked promising.

Immediately a major conceptual problem raised its ugly head. Noone in the Faculty knew what a resource centre was when it wasn't a library, this included the head of the centre, Dickinson, who had been trained for 2 decades to believe resource = library. Furthermore, being a Luddite, he believed library = books, and this was the general view of Faculty members.

Thus it was decided that while the corporate body evolved a working definition of a resource centre we'd start by buying some basic teaching manuals, self paced learning packages and reference books. Being then of a co-operative nature we followed university policy that all book orders went through

UTS library's acquisitions department. Nearly all these orders were rejected by the library on the grounds that

- they duplicated library holdings and therefore were wasteful in times of economic tightness
- we were usurping a library function.

This initiated correspondence between the faculty and the library that persists to this day.

A major change in thinking was needed. Dickinson consulted Peter Kandlbinder, the other author of this work, a technical officer with the Faculty, whose background, however, was in teaching and had experience with A/V production and computers. And the following is what we began to aim at.

Our obvious point to starting a resource centre was on the ashes of the old ITATE Library. The general belief amongst the faculty members was that they were getting a smaller version of this library with a larger emphasis being put on the audio-visual collection. The university on the whole strongly resisted this notion mainly it seems because the main library had plans to provide a similar service itself.

Is a Resource Centre different from a Library?

The question then was how exactly does a resource centre differ from a library. The two people that where given the responsibility for setting up the centre had all their combined experience in libraries and were still primarily concerned with the collections of books. The one thing that we where constantly being reminded of was that a resource centre was concerned with information not books. This, we came to conclude, meant that we had to concern ourselves with information in its broadest terms, be that collecting, storage, processing or the use of information. We were to become a sort of information broking service not tied down to any one medium, piece of hardware or software.

We were being given the opportunity to create the ideal resource centre, an area which would be open to all but servicing a particular clientele much in the same way that the ITATE Library worked with the adult education community. All the equipment and resources were to be available to individuals or small groups and technical help would be on hand to offer advice or help with the facilities.

The idea that this was going to be an area reserved for so-called 'media experts' was to be fought at all times. Some myths such as equipment is wasted on amateurs or that it suffers too much at their hands, making it unavailable to those that know what they are doing had to be broken down to prevent people from making this their personal domain, building up a type of technological snobbery, which unfortunately runs very strongly amongst technicians in particular, which tend to be concerned more by things rather than people. Our inerest was in developing programs whereby useful skills needed by people using technology can be passed on.

Ideally this resource centre would be developed to service its community. This meant developing a stratergy to provide equipment and facilities, access to information services and production facilities, or some combination of the three.

Equipment, be it video, photographic, audio or computer, requires more than just purchasing pieces which will make the room look full. It requires a commitment to provide facilities which are up-to-date, reliable and easy to use. Nothing causes more frustration, dampens enthusiasm and develops a fear of new technology quicker than being asked to use inferior materials, or gadgets which are unreliable. Almost as bad is buying something which looks dazzling is its brochure, but fails to impress in the flesh or like a child's toy remains abandoned and unloved because the people it was bought for can't find a good reason to use it.Consideration must be made to who will use it, where it will be used, for what and how often it will be used. Equipment selected must be the easiest to use, to maintain and must be the model that is most durable and for which service and parts are readily available

Staff need a commitment to befing involved in a resource centre. Conjoling and gentle encouragement is necessary to show the benefits of using something new, as there will always be people who ask, "If they've done without it for 20 years, why should we learn it now?" This calls for staff to understand the use of resources in education and to be sensitive to the everyday problems that face teachers. They must be trying to show them the best solution to their problem, be it old-fashioned or computer-age and not motivated by the latest acquisition from the equipment shopping list.

In fact it is our obligation to act in a mediatory role, to be used to link the ideas of others to the technology which is available. It is our job, in a manner of speaking to bring form to content. The academic staff which we service are all employed because they have a high level of expertise in some particular subject-matter, and it is for us to bridge the gap which exists between research and resources which already exist and the skills which exist within the faculty

To do this all staff must have easy access to information, especially current information on research and opinion which is relevant to their particular area of interest. If information is not available within the institution then there needs to be some means by which it can be bought, hired or borrowed. If the resources appear not to exist or are unobtainable then there is a need for some process by which they can be created. This makes the centre a pivotal point for news and ideas about educational development, possibly for such things as evaluation and assessment, inservice training, curriculum development, consultancy, new methodologies or new software and equipment.

With a production facility, the resource centre would be able to provide a service which can combine such varied areas such as media production with computer-based learning, psychology, evaluation or methodlogy . It can provide the neutral expertise which is content free, and that through a maximizing of skills, the information of others can be brought together in such a way as to provide the most practical and economical solution to a problem.

The area of production requires some caution, though, as it is vitally important that the centre does not make grandiose claims which it can not fulfil at all times. I would like to place some stress on that "at all times". There is a general feeling that technology is unreliable in either its machinery or its service which has caused its reputation in education to suffer. It takes many successes to show that something is worthwhile but only one failure to turn someone away for a long time. Any production facility requires a commited staff, as talented staff can take mediocre equipment, facilities and budget and provide a valuable service, but it can not be said that the reverse applies.

A resource centre must always be more than just a place which hands out audio-visual aids, with their stigma of being just add-ons, unessential and dispensable. It can have a role as the agent of change for the faculty, and how people deal with information technology. Above all it must be available to all, easy to use and have a pleasant atmosphere. It needs to be a place where people want to come, where they feel welcome, relaxed and unthreatened and above all they need to feel that this is a place being run for them.

So after a year does the Faculty of Education have this ideal resource centre?
We would have to say far from it, but for good reasons.

Firstly it could not be our goal to set up a resource centre in the quickest possible time. This facility has to evolve, provide services which are valuable to the people which are going to use it and are offered in a systematic way so that the use of the facility can become obvious to all that use the university. People need time to adjust and the growth of the centre needs to take place slowly, developing alongside of the needs of the people it services.

The resource centre is trying to be more than just a holding area for equipment. We are trying to develop the concept that it is a place and a process as well as a set of facilities. In the first instance it will be the place where practicioners go, formally and informally to get assistance with problems they face in their work as adult educators. Later we hope to serve the wider adult education community, particularly the more poorly resourced sections of that community, by providing space where adult educators can meet and exchange ideas.

This is led by to two sets of assumptions underlying the operation of the Centre. Firstly, the nature of adults as learners, being that adults make and are responsible for their own decisions, that they are experienced , achievement-orientated and judgemental.

Secondly, concerning the nature of practitioner growth and development, the notion that lasting and effective change in the education process will come about through the efforts and activities of grass-roots practioners.

In the initial stages there have been many who have found it difficult to adjust to this new environment resulting in a certain amount of inertia and apathy.
To bring this concept of a resource centre into the realm of the immediately obtainable we invested heavily into equiping the centre with practical and useful items designed to allow lecturers and students to develop materials for use in their learning programmes.

What is evident with areas such as computer-directed learning, which embraces all subject areas, is that it can not taken on by one department to provide a facility which could address the full scope of educational media. Computer skills, which offer an ease of management, professional results and cost efficiency needs access to an extensive library of software and expertise, in their broadest meanings, and are best serviced by a unit outside of departmental structures, to allow free movement between departments without threat of intrusion.

We found the best way to create such a facility was with a two-pronged strategy. Firstly to assemble and supplement the existing equipment to meet our agreed upon goals and secondly to develop and budget for a high-end system based on Macintosh computer, in which the Faculty has already invested quite substantially.

Our aim is to build a library of reference materials; be they books magazines, CD ROM, graphics, music, slides, or clipart; collected for use with the workstations and it would be expected that staff and students would generate some of this material during their class time

The more traditional media techniques for generating graphics, printing, drawing, model making and display materials would be developed concurrently, offering the staff and students opportunity to individualise their work.

It matters little in which direction we started, it was essential to realise that it was just a start and we developed a buying program which will be extended over a number of years so that we will be able to concentrate in equiping our staff members with specific equipment and materials as they are ready to use them effectively.

We made virtually no attempt to providing facilities for production, because of the of the cost, level of sophistication necessary and the lack of staff available.Instead we continue with our traditional role of support for the formal teaching programs of the Faculty, with appropriate audio-visual and computing resources. Essentially we have maintained and tried to develop the technical support essential to the effective operation of the Faculty.

We aimed to promote a climate which encourages the development of co-operation between and among practitioners, based on the principle that professional education is not only a series of organised lecture-centred courses, it can also be a self-directed pursuit.

Information about the centre is disseminated through a regular newsletter.and we have found our greatest area of development is in the sharing of information between practitioners. Networking with computers bridges barriers and people have been quick to see the potential for building their communication links.

We hold the belief that there exists among practitioners a vast reservoir of largely untapped expertise and talent, and that the good practioner has great potential as the educator of other practioners. The feeling is that a unit like this one can provide a neutral arena where lecturers, students and technical staff can work as colleagues, free of many of the constraints, pressures and hierarchical structures inherent in many educational practices.

The future.

Those that look for the ideal conditions in terms of equipment and buildings have a blinkered view of what educational technology involves. Above all it involves people, and the reasons for their support is crucial. The central issue must be the resource needs of adult learners not arbitrary decisions about systems, purchases and management methods.

This facility will have an up-hill struggle if there is a lack of real comprehension of what the unit should be doing and the objectives that it should be striving to achieve.

To keep pace with the changes in teaching it is necessary for our facilities to address the new directions in education. New technology, we have found, does not supersede the old but rather builds upon its foundations and tradition resources remain as much our priority as new developments.

It has been decided that an Educational Resource Centre which is capable of capturing, storing and publishing multimedia documents composed of human voices, moving images, photographs, and three dimensional models, as well as numbers and words, would benefit the Faculty, educators and students Our goal now is to offer lecturers, students and practicing teachers access to facilities of information retrieval, to allow the flexible manipulation and ability to customise information, putting it in a form which is usable for a particular purpose

The sort of successes that are often touted by educational technology are seldom achieved through the efforts of one or two individuals. A perceived failure to produce results has already taken its toll of staff moral and hampered the credibility of educational technology. We want to ride the wave of interest growing from the promise of computerised multimedia, but can only reinforce the existing trends within the education, either the trends that are already recognised and developing within the institution or those that are currently being explored within the larger field of education.

Our priorities for next year include; defining our short and long term objectives regarding the role of the centre, its relationship with newly formed schools and its importance in the Faculty.

We will begin to persuade/coerce staff into becoming more involved, trying to discover the real issues that are relevant to those staff concerned.

We have begun to publicise the facilities, the services and work of the centre and to offer training courses to staff. We provide space where practicing adult educators can meet and exchange ideas, work individually and in groups to solve teaching/learning problems, and hope to strengthen links with the Faculties former students.

Above all we will be working towards establishing links within the network of adult educators. This process of interaction with others is concerned with the spread of ideas, and the possibility of assisting with the improvement of the educational process. If one considers this attempt to promote the spread and adoption of new ideas and practices, then we feel, clearly we are part of the process of change.

THE USE OF AUTHORING TOOLS IN INSTRUCTION FOR EQUIPMENT USE

by

B M Harper, A M Harper, M D Imisides,
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ABSTRACT

Training in the use of scientific equipment is time consuming and costly and often few instructional resources are included with an equipment purchase. Users in industry and in tertiary institutions need to quickly put the equipment to use rather than spend large amounts of time developing the necessary skills to make effective use of the equipment. This paper describes the application of a CAL authoring tool, HyperCard, to develop a tutorial for instruction on the use of scientific equipment attached to a Macintosh computer. The HyperCard stack developed, using the team approach to courseware authoring, effectively instructs users in the use of the equipment and presents a tutorial on the associated subject content, electrochemistry. This type of application of CAL, and in particular authoring tools such as HyperCard, is an obvious and appropriate application of instructional technology.

THE USE OF AUTHORING TOOLS IN INSTRUCTION FOR EQUIPMENT USE

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Introduction

Traditionally hardware suppliers provide a manual which usually only contains the technical aspects of the equipment. Because of the complexity of much of modern equipment, hardware manuals are often complex, as they must be, and often difficult for operators that are not experts but still need to use equipment to obtain accurate measurements. Instructors who need to use this type of equipment with students have also often needed to design their own experiments and simulations to familiarize students with equipment workings and the scientific principles involved. Equipment attached to computers have the inbuilt instructional resource of the computer available. One solution that equipment manufacturers could adopt is to use sophisticated tutorial packages, in the same way that computer software manufacturers do for their software packages and plug in peripherals.

The difficulty of this approach is that you are dealing with a clientele who have a variety of backgrounds and understandings of the often complex processes involved with the equipment and so tutorials must be designed to cater for a broad range of users.

Traditional tutorial systems have tended to be linear in that the users were locked into a fixed path which was a characteristic of the authoring system rather than a deliberate design characteristic based on sound instructional principles. More sophisticated implementations have incorporated feedback and explanatory loops but it has been difficult to cater for the full range of users using these types of techniques. The introduction of new authoring tools, based on the hypertext concept, has allowed instructional designers to design exploratory systems that enable experts to skim the basic concepts and techniques as well as allowing novices to examine the full detail of explanations of procedures and processes. This type of application of CAL to equipment familiarisation, and in particular the use of authoring tools such as HyperCard in these circumstances, is new and yet is an obvious and appropriate application of instructional technology.

This paper describes a tutorial package designed using the interactive instructional environment of HyperCard in conjunction with an electrochemical analysis system called ElectroLab™, attached to a Macintosh computer.

The ElectroLab™ System

The ElectroLab™ system, developed by Bionexus Pty Ltd (1), was designed with a view of both simplifying the experimental setup and providing a basic training facility in the principles involved in the complex chemical processes of electrochemical analysis. To achieve this an electrochemical workstation has been developed based on an Apple Macintosh™ computer.

The hardware component of this equipment consists of an interface unit, based on the Apple Lab unit, a potentiostat for setting the electrochemical analysis potentials, and an electrochemical analysis cell. The technical details of this equipment have been reported in another publication (2).

The software supplied with the workstation consists of two components; the workstation operating software and a tutorial in the form of a HyperCard stack. One of the objectives incorporated into the development of this system was to supply a basic training facility for the electrochemical process of voltammetric stripping analysis. This objective was addressed in two ways.

Firstly the operating software was designed to make the best use of the intuitive features of the Macintosh graphic user interface The Macintosh™ graphic user interface is widely accepted as being more efficient, more productive and easier to use than command driven interfaces. The use of high resolution graphics, pull down menus, explicit menu item headings, dialogue boxes and menu command selection using a point and click mouse are essential tools in the delivery of these benefits. The desktop metaphor of the Macintosh has been exploited effectively in the ElectroLab™ software to enable an intuitively simple setup sequence to be used in the experimental design and operating procedures of the system. This type of facility allows users to explore the fundamentals of the technology while the software takes care of the setup procedure(3).

Secondly the tutorial was designed to give the user an introduction to the basic principles of voltammetric stripping analysis, illustrate the setup procedures, simulate the stripping process and to present detailed information for the experienced electrochemist. Wherever possible high level graphics and even animations have been used to create an informative visual presentation of the conceptual basis of the techniques. An extensive glossary is an important feature of the tutorial, allowing the user to familiarize themselves with the scientific terminology used throughout the package without losing the direction of enquiry within the tutorial.

Authoring Approaches

There have been various models of courseware development proposed and Squires and Millwwood(4) have reviewed the influence of new software, such as HyperCard, on the development of instructional packages. Two comparitively distinct models of courseware development can be commonly found:

a) the individual author approach where one person acts as a curriculum expert, content expert, programmer and instructional designer and
b) the team approach which enables a division of labour into experts in each of the specialized areas.

The team approach to courseware development has considerable advantage over individual authoring. Team development provides a rich environment within which the various team members provide unique contributions. However, the development of high level general purpose programming languages has empowered educators with the tools to achieve sophisticated prototypes without relying on expert programmers. This project was developed using the team approach with content and equipment experts developing the basic content outline, an educationist designing the instructional sequences and the screen formats and a programmer scripting the HyperCard stack. The advantages of this approach were that the focus of the content experts ensured accuracy in the content and terminology and the educationist could design instructional sequences to maximise learning outcomes and incorporate the flexibility needed to cater for a variety of user skill levels. In this way the educationist or content expert are not constrained by their own programming skills, but could be innovative and creative in design, leaving the difficult programing problems to the skilled programmer.

HyperCard as an Authoring tool

Squires and Millwood(4) have stated that some of the newer languages such as hypertalk, the programming language of Apple's development system, HyperCard, "... are based on cognitive models of how people learn in such a way that they make the environment of the computer available, relevant, rich, and malleable to the user". Christina Hooper (5) supports this interpretation of the pedagogical ideas behind HyperCard ".... HyperCard is fundamentally designed to address how people think .... We can now design pedagogical surrounds with tools designed to be compatible with mental activities." The development of this type of authoring tool has allowed the application of a broader variety of instructional models to CAL.

HyperCard is well suited to courseware development. It uses a rolodex card metaphor to display new screens called cards. The cards are created with tools similar to those used in graphics programs such as Macpaint and the user interface objects, buttons and fields, can be rapidly produced, illustrated and placed to act as "hot spots" that respond to the users mouse click to initiate action. The visual nature of the user interface is supported by the use of graphic representations of the functions of the various buttons in the form of Icons.

The tutorial described here was developed using Apples powerful HyperCard™ environment which allows access to data in a non-sequential flexible and intuitive way. The "browse" facility of this package allows users to move from one place or idea to another through a web of associations. This facility increases the versatility of the instructional process so that novices can follow a set path while more experienced users can choose the detailed information sought.

HyperCard has the added advantage that it can be extended using the inbuilt external interface. The external interface provides the means for rewriting or creating new HyperTalk language commands (XCMD's) and functions (XFCN's). The great advantage of this facility in this type of application is that the HyperCard tutorial can access the operating software so that simulations of the various setup functions can be reproduced exactly as they would appear in the application.

The Tutorial HyperCard™ Stack

The tutorial is structured with a series of screens which introduce the user to the basic principles of electrochemistry, the equipment components of the ElectroLab™ system and the basic navigation icons. This is followed by a branching screen with selection boxes for each of the four methods of electrode stripping. Each branch leads to descriptions of the particular type of electrode stripping and then a further branch is available for the set of experimental parameters (Figure 1). The tutorial also incorporates an extensive glossary, accessible from any part of the tutorial through "hot buttons" indicated by underlining of words.

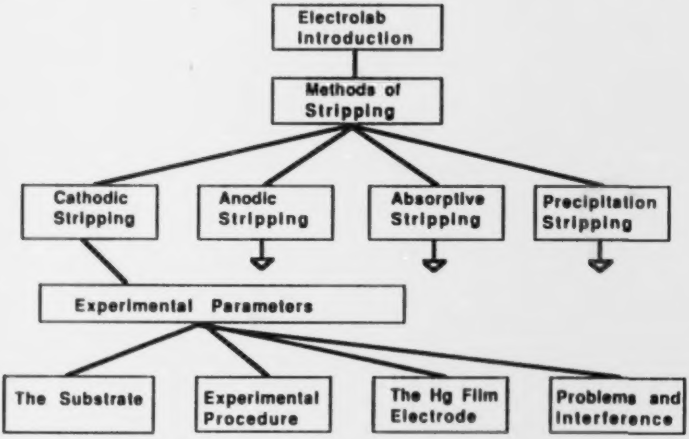
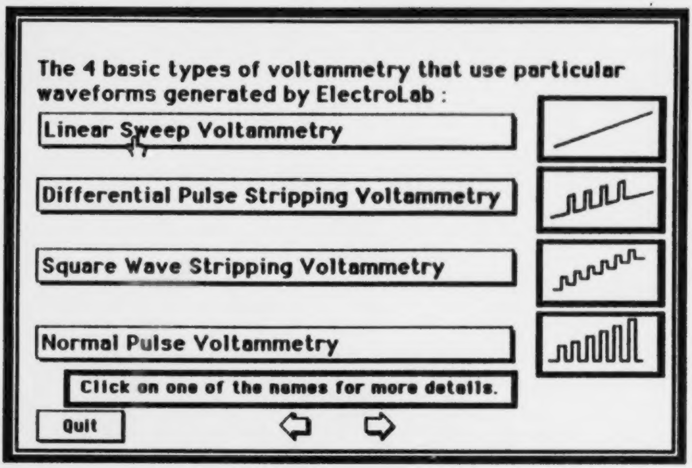

Electrolab Introduction
Methods of Stripping
Cathodic Stripping
Anodic Stripping
Absorptive Stripping
Precipitation Stripping
Experimental Parameters
The Substrate
Experimental Procedure
The Hg Film Electrode
Problems and Interference

Figure 1. A schematic diagram of branching within the tutorial stack



The 4 basic types of voltammetry that use particular waveforms generated by ElectroLab :

Click on one of the names for more details.

Linear Sweep Voltammetry
Differential Pulse Stripping Voltammetry
Square Wave Stripping Voltammetry
Normal Pulse Voltammetry
Quit

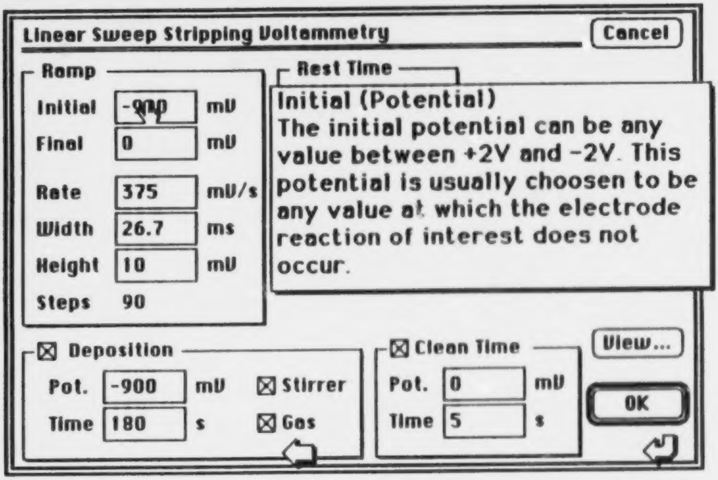
Figure 2. This diagram shows the selection screen for the four types of voltammetry addressed in the package.

Correct setting of the electrode parameters is essential for voltammetric stripping and tutorial users can access a detailed explanation of the waveforms generated by the ElectroLab™ system. Figure 2 shows a selection screen for the four types of voltammetry addressed in the package. Icons, representing the various types of waveforms illustrate each button.

The waveforms branches also have explanations of the various set up screens with "hot buttons" embedded in each of the parameter boxes. As a parameter box is chosen a dialogue box appears on the screen with an explanation of this parameter. Figure 3 shows a typical waveform setup screen (this one is for linear sweep stripping voltammetry) with the dialogue box for the initial ramp voltage shown.

An Example from the Tutorial

Voltammetric stripping analysis is a sensitive and versatile analytical method suitable for the determination of a range of elements. The steps involved in voltammetric stripping analysis consist of a chemical and an electrochemical component. Both components act in unison. In order to illustrate this process visually, a simple animation is used in the the ElectroLab™ tutorial to summarize and illustrate the process. As the applied analytical waveform is varied in the electrochemical cell, the electrode undergoes chemical change which results in an analytical signal being produced at the electrode. This signal is received by the



Linear Sweep Stripping Voltammetry

Cancel

Ramp

Initial -900 mV

Final 0 mV

Rate 375 mV/s

Width 26.7 ms

Height 10 mV

Steps 90

Rest Time

Initial (Potential)
The initial potential can be any value between +2V and -2V. This potential is usually choosen to be any value at which the electrode reaction of interest does not occur.

☒ Deposition

Pot. -900 mV

Time 180 s

☒ Stirrer

☒ Gas

☒ Clean Time

Pot. 0 mV

Time 5 s

View...

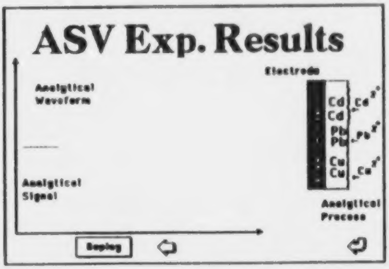
OK

Figure 3. Showing a waveform setup screen for linear sweep stripping with the dialogue box for the initial ramp voltage shown.

ElectroLab™ interface unit and displayed by the operating software on the Macintosh screen. The process is illustrated in the tutorial package in the following way.

Step 1 Deposition:

The initial step involves the deposition of an analyte onto an electrode surface as a means of preconcentration (Figure 4). The animation shows a simulation of the electrode surface and associated species, on the right of the screen, and the applied signal (waveform) together with the resulting electrode current.



ASV Exp. Results

Figure 4. Simulation of the electrode surface and associated species, on the right of the screen, and the applied signal (waveform) together with the resulting electrode potential.

Step 2 **Stripping:**

Following the deposition step, the analyte is electrochemically stripped from the surface to generate the analytical signal. To achieve this the potential applied to the electrode is changed (shown as the analytical waveform) and the analyte on the surface is either oxidised or reduced and subsequently leaves the electrode (Figure 5). As a result of this reaction, which involves electron transfer, current (shown as the analytical signal) flows through the electrode.

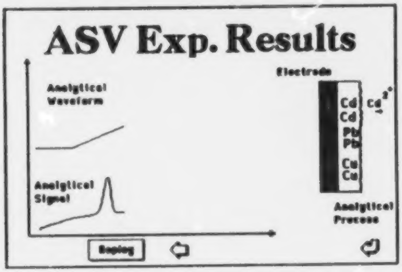

ASV Exp. Results
Electrode
Analytical Waveform
Cd
Cd
Pb
Pb
Cu
Cu
Cd^{2+}
Analytical Signal
Analytical Process
Replay

Figure 5. Screen showing the simulated signal produced for the oxidation of Cd accumulated at the electrode during step 1.

The potential applied to the electrode is continually increased until all of the analyte has reacted and left the electrode surface. The resultant analytical signal is shown at the bottom of each of the figures.

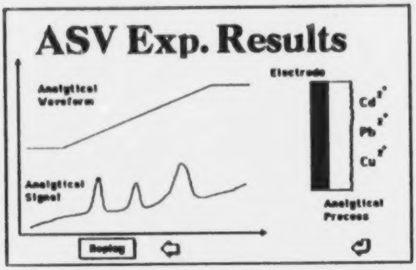

ASV Exp. Results
Electrode
Analytical Waveform
Cd^{2+}
Pb^{2+}
Cu^{2+}
Analytical Signal
Analytical Process
Replay

Figure 6 Screen showing the signal produced for the oxidation of Cd, Pb and Cu accumulated at the electrode during step 1.

The transition between the preceding screens (figures 4 to 6) is achieved using animation sequences which simulate the analytical waveform and analytical signal as well as the species transfer processes at the electrode. This is a complex process and yet with the use of HyperCard as the authoring tool, the animation process can be achieved quite simply. A replay button has been incorporated into the animation so that the user can review the animation as many times as required.

Conclusion

The use of authoring tools such as HyperCard, in the development of tutorial packages designed to instruct in the use of complex scientific equipment is an appropriate and effective application of CAL. The versatility of HyperCard allows instructional designers to incorporate a variety of instructional techniques which can allow novices and experts to use the same package in different ways.

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TEACHING WITH TELEMATICS

USING TELEMATICS TO INCREASE ACCESS TO INFORMATION AND BROADEN THE CURRICULUM

by

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Telematics, a term developed in educational circles, describes both the electronically-based equipment and the processes and strategies used, to enable interactive teaching and learning between two or more geographically different locations. The Ministry of Education in Victoria has used Telematics to assist in broadening curriculum available to students in rural locations. Groups of schools have formed into clusters based mainly on the local geography, to share the available teaching resources.

Teachers using Telematics operate in an **extended classroom** environment, to instruct students in a remote school and in their own school simultaneously. Total class sizes are kept small to allow for maximum interaction. Up to three different links using varying forms of technology, may be used to bring the students and teacher in contact with each other.

Firstly an **audio link** is created by loudspeaking telephones, or for larger groups, full audio conferencing units. These provide good voice contact, with hands-free operation, to allow for flexible group size, movement and easy interaction. The Ministry of Education's Telematics staff are constantly monitoring technical developments and new product releases in the audio link arena.

The second link - the **document link** - is basically provided by a facsimile machine which enables the transfer of documents. Using this facility teachers are able to 'handout' activity sheets or receive homework etc from the students. When presentation of the work is important, assignments for example, use is made of Australia Post or teachers/parents travelling between the various schools.

A minimum of one telephone line is required for this style of teaching. As the usage rate increases, however, the fax and audio device that share that one line are best separated, with the addition of a second telephone line, to create easier accessibility to the facsimile. Developments currently underway aim to combine Voice and Data simultaneously on the one line using a new style of modem. Once again, the Ministry's Telematics Team is monitoring and liaising with developers and manufacturers as they work to fine-tune and enhance this aspect of the technology.

The third link or **visual link** centres around the use of a computer to provide an interactive 'blackboard' for both teacher and student(s). A great deal of developmental work has taken place in Victorian schools to create a product that meets the very specific needs of the extended classroom concept. The following equipment is now used:

- Macintosh computer, preferably with a second drive
- Automodem capable of 2400 or 1200 full duplex
- A third telephone line
- Graphics Tablets, if a good deal of handwriting is required
- Liquid Crystal Display unit and Overhead Projector to cater for larger groups
- **Electronic Classroom*** software

* Electronic Classroom is an Australian developed and written software package which has been designed with the 'extended classroom' concept in mind. The teacher and student are provided with a common 'blackboard' with word processing and graphics facilities. For example, a teacher may draw a rectangle, type a question and then ask the students to name and estimate the angles. Transfer of data in this mode is virtually instantaneous although prepared files may take between 10 and 30 seconds depending upon their complexity. The computer screen then provides a focus for student attention as they listen and talk with their teacher.

Almost all areas of the curriculum are being taught via this telematic method in various locations across the State. While **it is not claimed to be as good as traditional face to face teaching**, it does provide students with greater curriculum choice without the need for undertaking studies by correspondence; ie in the more traditionally accepted no interaction mail sense.

Several very useful side effects have surfaced for students studying in this manner:

- greater awareness and skill of the technologies involved (especially for girls who may not have taken a traditional computer subject)
- greater responsibility assumed for one's education
- the chance it provides for teachers to review the curriculum they are teaching along with appropriate modes of delivery

In recent months the Ministry of Education in Victoria has taken the further step of creating a small cross-sectoral team - **the Telematics Network Project Team** - to further develop and promote the work already being done by the various divisions of the Education Ministry - Schools, TAFE Colleges and the Division of Further Education. The team has initially researched the various approaches, achievements and aspirations of each of these sectors and in 1991 is endeavouring to establish and build a network of confident and competent

Telematics teachers and educational administrators throughout the State. The sharing of the information between various sectors should provide the basis for closer cooperation between the sectors and provide students of all ages throughout Victoria with access to a broad and innovative curriculum so necessary for life in the 1990s and beyond.

THE FUTURE OF INTERACTIVE VIDEO/AUDIO TECHNOLOGY IN SUPERVISING STUDENT TEACHERS

by

Mildred Johnson
and
Barbara Clawson

ABSTRACT

The purpose of a three-year project conducted at the University of North Carolina at Greensboro was to improve student teacher analysis of teaching through reflective feedback sessions via an integrated communication system. Specific objectives for the project were to: (a) identify an integrated communication system, (b) conduct a pilot study with a cooperating teacher, (c) implement the system with a student teacher, and (d) evaluate the effectiveness of the system for use in supervision.

The communication system selected was the Minx™, a two-way interactive video, audio, data full motion system, by Datapoint, Cablevision channels were used as the linkage medium. The second year of the project the system was implemented with the cooperating teacher. A supervisory model and guidelines for reflective conferencing were developed.

In the third year the system was used in the supervision of a student teacher. Each morning a brief conversation was held between the student teacher and/or cooperating teacher and the teacher educator. If classes were to be viewed, a preconference was held with the student teacher to discuss her plans for the class. The teacher educator then viewed the selected class "live" or taped it for review at a more convenient time. After the student teacher and cooperating teacher had an opportunity to view the tape the conference was held. At this time, the student teacher was encouraged to analyze the class session in terms of student reactions, extent to which her objectives were met, alternative ways of handling situations, and extent to which aspects included in the North Carolina Teacher Performance Appraisal instrument were exhibited.

Advantages of using the audio-video system included more frequent contact with the student teacher and cooperating teacher, more flexibility in choice of classes to be observed and analyzed, and enhanced ability of the student teacher to reflect upon her teaching as a result of viewing the tape prior to the post conference. Use of the integrated communication system has strengthened the interactions among the teacher educator, cooperating teacher, and student teacher. More opportunity has been provided for careful analysis of the teaching act due to the capabilities of the system used. It is recommended that continued use of this process be explored in the supervision of student teaching.

THE FUTURE OF INTERACTIVE VIDEO/AUDIO TECHNOLOGY IN SUPERVISING STUDENT TEACHERS

by

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The wave of educational reform movements that has dominated the educational landscape during the past decade has important implications for the preparation of future teachers. The impetus for the reform movements in the early 1980s was the belief that the educational system was failing to properly educate our youth and during the later years of the 80s the assumption was that the problems in education were due to the structure of schooling. It was in response to the initiatives addressed in the many reform movements that we as teacher educators raised the questions: "What could be done to improve the undergraduate teacher education program?" and "What aspect of the program was of greatest importance in the development of teachers? These questions led to thinking about the student teaching experience. What could be done to increase the ability of the student teacher to analyze his/her own teaching and thus improve classroom instruction?

One reason for focusing on student teaching is that it has been described as the most important component in the preparation of teachers (Brimfield & Leonard, 1983; Richardson-Koehler, 1988; Zahorik, 1988; O'Shea, Hoover, & Carroll, 1988). The norm tends to be learning to teach by experience rather than through observation and analysis. Cooperating teachers tend to be more oriented toward the practical and particular than toward theory and generalization. In addition, their full schedules limit the time available for conferencing and analysis. The university supervisor is often unable to contribute effectively to the student teacher, cooperating teacher, university triad. In many instances, the supervisor is caught between the demands of university responsibilities and student teachers and thus cannot spend the time necessary to build trust. The limited time spent in the classroom does not lend itself to the type of trust-building and reciprocity necessary for collaborative, reflective feedback sessions and for rigorous analysis of teaching (Richardson-Koehler, 1988).

Because supervision is such an important element in student teaching, a supervisory process which could enhance the relationships among those involved in the student teaching experience would be beneficial. It was believed that one solution to providing a stronger linkage between student teachers and teacher educators would be through the use of a two-way interactive integrated communication system that combines video, audio, and data communications.

Much of the technology needed to implement an integrated communication system has been available since the mid-60s but unfortunately the implementation has been minimal (Salser, 1987). There is a need to incorporate the best uses of technology to improve the preparation of teachers. The end result could well be a cost-effective, active, learning environment.

In an attempt to address these concerns a three-year project was designed to implement the use of an integrated communication system in the supervision of student teachers. This project was funded by the Division of Vocational Education Services, North Carolina State Department of Public Instruction. It was believed that use of this system could strengthen the linkage between student teachers, cooperating teachers, and teacher educators and improve the analysis of class sessions.

The objectives for the project were to: (a) identify/select an integrated communication system that combined video, audio, and data communications as a vehicle for linking student teachers, cooperating teachers, and university supervisors; (b) conduct a pilot study with a cooperating teacher using the communication system; (c) implement the supervisory model with a student teacher; and (d) evaluate the effectiveness of the system in terms of the supervisory process.

Procedures

First Year

Much of the first year was spent (1) reviewing the literature pertaining to the use of audio/video communication systems in educational settings; (2) visiting sites to become familiar with the uses of technology, equipment, and facilities; (3) attending a national conference on distance learning and trying to identify potential communication systems; and (4) making telephone contacts with persons who were using technology in educational settings to determine whether their use of technology related to the project and if a site visit would be beneficial.

Based on the information obtained from the sources indicated previously, four telecommunication models were designed. The first was a **two-way interactive audio system with video copied and sent to back to the university supervisor.** The second model was a **two-way interactive audio/one-way still video with interactive board** that offered two-way audio with one-way video played from the base site to the remote site in a stop-motion format. A **two-way interactive audio-video (slow scan or stop motion)** comprised the third model. The fourth model was **two-way interactive audio-video (full motion).** This model would allow two-way full motion color video and two-way audio interaction between the university and a remote site.

The criteria established for the selection of the communication system were:

1. Two-way TV utilizing full motion video and audio
2. VCR recording capability at both locations
3. Data transfer utilizing FAX or MODEM
4. Minimal set-up/tear-down requirements for personnel
5. Minimal operation requirement during transmission
6. Cost within project funding.

The two-way interactive audio-video (full motion) was the model that meet these criteria. The communication system selected for use in the project was the MINX™ (Multimedia Information Network Exchange™) by Datapoint Corporation. It is a compact workstation unit about the size of a large TV with a built in camera, microphone, monitor, and jack box. It is also possible to connect additional microphones, cameras, video cassette recorders, computers, and FAX machines into the workstation unit. In addition to the workstation unit, the MINX system includes a "cluster server" at each end to combine workstations for transmission over a carrier medium. Each cluster server can accommodate up to eight workstations. Through the cluster servers the MINX workstations are interconnected (bridged) for full interactive teleconferencing and data transmission. The system has been tested and used, requires minimal technical knowledge to operate, and has minimal set-up/tear-down requirements.

The Datapoint system may use either a digital transmission signal, such as a CODEC with 56 KBS, T-1.5 telephone service, satellite, microwave or fiber optics; or an analog transmission signal such as a TV cable service. Of these alternatives, cable was the only one feasible in terms of cost and availability. Contact was made with a Cablevision company regarding the possible use of their lines for signal transmission. It was indicated that for limited daytime hours service could be provided for the project. A method of scrambling the transmission was agreed upon so that the privacy of the teacher and students would not be violated.

Criteria used in selecting the local high school and teacher to participate in the study were: (1) willingness of school to participate, (2) appropriate for use as a student teacher center, (3) fully certified teacher, and (4) currently on the Cablevision line. Permission was obtained from the superintendent of schools to contact a principal at one of the high schools to explain the intent of the project. The teacher was contacted, the project explained, and her consent to participate was obtained.

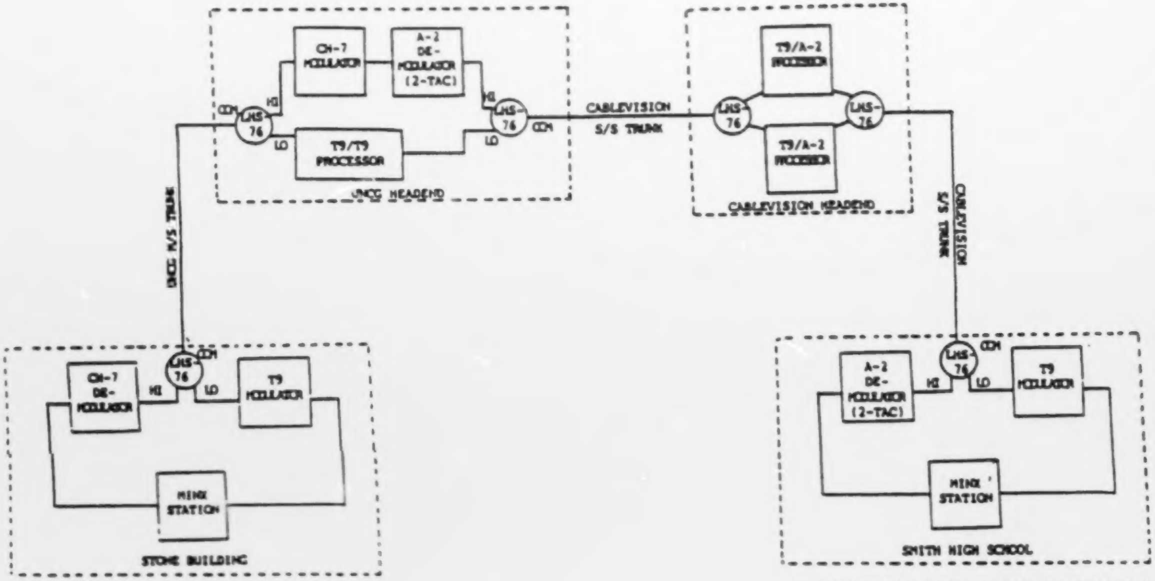
Second Year

During the second year of the project the equipment was purchased and installed at the university and in the selected high school. Equipment used at UNCG included the MINX workstation and cluster server, a VCR, and TV monitor. The other MINX workstation and cluster server were located at the high school. The equipment was placed on a cart stored behind a storage area to decrease student awareness of its presence. Placing the equipment on the cart also made it convenient to store it in a locked area when not in use. A detailed diagram of the network is shown in Fig. 1. At the high school site, an additional departmental camera from UNCG was placed in the back of the room above the storage cabinets to film more of the classroom than was possible with the MINX camera. Although the camera was stationary, it was possible to see the major portion of the room. In most cases, only the backs of students could be seen.

In order to test the system, the potential cooperating teacher was asked to turn on the MINX in the morning and leave it on during the entire day. It was also turned on at UNCG each morning. From time to time, it was agreed that certain classes would be videotaped. The videotaping was successful and one of the tapes was played back to the teacher during a simulated conference. The major difficulty encountered in using the MINX system in the classroom setting was the ability to hear comments made by the students. Several different microphone arrangements were tried to alleviate the difficulty.

In preparation for the pilot study with a student teacher in Fall 1989, several supervisory models were examined, e.g., reflective and clinical models. The Association of Supervision and Curriculum Development videotapes and accompanying materials, "Another Set of Eyes," on questioning skills in supervision, were reviewed and used in a simulated conference with the teacher participating in the study. The supervisory model developed included a preconference, observation and analysis of the class session, and a post-conference. Sample questions for use in each stage of the model were developed and evaluation forms for use during observation of teaching were also reviewed. Interviews with students in the high school and the teacher were conducted after the pilot test of the system was

FIG. 1 - A/V I-NET BLOCK DIAGRAM, UNCG STONE BUILDING - SMITH HIGH SCHOOL


CH-7 MODULATOR
A-2 DE-MODULATOR (2-TAC)
COM
LHS-76
HI
LO
T9/T9 PROCESSOR
UNCG HEADEND
CABLEVISION S/S TRUNK
T9/A-2 PROCESSOR
T9/A-2 PROCESSOR
CABLEVISION HEADEND
UNCG M/S TRUNK
CH-7 DE-MODULATOR
T9 MODULATOR
MINX STATION
STONE BUILDING
A-2 DE-MODULATOR (2-TAC)
T9 MODULATOR
MINX STATION
SMITH HIGH SCHOOL

Prepared by UNCG - Telecommunication Department completed to determine reactions to the process. It was apparent that the process and equipment did not affect the behavior of the students. Students stated that they would behave the same way whether being seen and/or taped or if an observer were in the room. The teacher thought that the students might have been better behaved if the observer were in the room. The suggestions offered during the interviews were helpful and were incorporated into the guidelines for using the system.

When the cablevision channels were no longer available for use during the second year, the MINX system used at the high school was set up on campus so additional time could be spent writing guidelines for using the equipment. Several different simulations were conducted with the equipment between the two sites in an effort to identify possible aspects of the process that might be improved to enhance the effectiveness of the system and the supervisory process. Work was done with the technical consultants on campus and with cablevision and with the prospective student teacher. In order to familiarize the student teacher with the system, she was given an opportunity to teach a short lesson and to experience the observation and conferencing components of the model. It also provided an opportunity for the researchers to become more proficient in using the equipment.

Third Year

The communication system was used in the third year of the project to supervise a student teacher. The MINX workstation was installed again at Smith High School and the communication and linkage systems were tested to make certain that everything was functioning properly. The classroom was rearranged so that a side view of the students was filmed rather than their backs as in the previous year. It was discovered that the MINX camera provided a satisfactory view of the classroom. It also required less set-up time for the teacher because she did not have to station the additional camera as was done in the pilot study. In addition, it was decided that the microphone on the MINX picked up the students' comments as well as the additional microphones used in the pilot test. This necessitated placing the MINX unit in the back of the classroom rather than behind the storage area. Students appeared to pay little attention to it after the first few days. The extra camera with the zoom lens was used when the students or teacher were in the laboratory on the far side of the room.

At the beginning of the fall semester, a conference was held with the cooperating teacher and student teacher to go over the guidelines for reflecting on teaching and the use of the communication system. Each morning the system was activated and a brief conversation held among the student teacher and/or cooperating teacher and the teacher educator. It is important to note that the system must be activated at each location; thus, it is impossible for a classroom to be observed without the knowledge of the teacher. If the classes were not to be viewed that day, the system was turned off. If classes were to be viewed, a pre-conference was held with the student teacher to discuss her plans for the class to be observed. The teacher educator then viewed the selected class "live" or taped it for review at a more convenient time. After the student teacher and cooperating teacher had had an opportunity to view the tape, the post-conference was held. At this time, the student teacher was encouraged to analyze the class session in terms of student reactions, extent to which class objectives were met, alternative ways of handling situations, and extent to which aspects included in the North Carolina Teacher Performance Appraisal Instrument were exhibited. Thus, the integrated communication system provided a means for observing classroom instruction, video taping the instruction, reflecting on the instruction, playing back the tape, and conferencing with the student teacher and cooperating teacher in a non-traditional way.

Findings

Interviews were conducted with the student teacher and cooperating teacher at the end of the student teaching experience. The student teacher was asked how she would describe her experience with the MINX, her reactions to being taped and the more frequent contact with the university supervisor, the effect viewing the tapes had on the analysis of her teaching, the effect of the presence of system on student behavior, and advantages and disadvantages of using the MINX for supervision.

In response to the question about how she would describe her experience with the MINX, the student teacher said that at first it felt like "big brother watching you" and that it was stressful. As time passed, however, she grew accustomed to the MINX and didn't think much about it after it had been turned on. In fact, she said that toward the end of the semester it did not bother her at all and that she would probably have been more intimidated having a person in the room. She commented "I could distance myself between the camera and UNCG even though I knew you could see exactly what was going on in the class. I could still mentally protect myself by thinking they are just at UNCG and not here."

She liked the more frequent contact with the university supervisor, especially at the beginning of the semester. She stated, "It was reassurance that I was not left out there on a desert island by myself. I liked the day-to-day contact and encouragement."

The student teacher indicated that the preconference had several benefits. It encouraged her to be better prepared for class and gave her a chance to share her plans as well as indicating particular components of the teaching act about which she desired feedback. She also thought that the conference gave the university supervisor an opportunity to obtain information about previous classes and how the class that day fit into the sequence of learning activities.

In response to the question about effect of the system on student behavior, she indicated that after the students grew accustomed to having the equipment in the room, she did not believe it affected their behavior. When asked whether or not it would have made a difference in her behavior had the University supervisor been present in the room rather than via the MINX, she stated, "My teaching behavior may not have been different, but my mental state of mind would have been a whole lot different. I would have been more nervous and that might have shown through in my teaching. I would have wanted to be sure everything was just right because someone was out there watching me, whereas with the MINX, I was more relaxed and didn't think much about it."

The student teacher believed that the opportunity to view the tapes of her class sessions prior to the post conference helped her to see "how well the class actually went." At first she focused more on her own behavior, but gradually she paid more attention to the students' behavior and their reactions to the class.

The major advantage she identified of this approach to supervision was the frequent interaction with the university supervisor. "I felt like I didn't have just one teacher and that we were all in this together. The university supervisor was part of my experience and I could ask her things just like I could my cooperating teacher. In addition, the university supervisor probably got a better picture of how I was progressing because she saw each step along the way."

When asked to what extent she felt prepared for the observations/evaluations which she would experience as a beginning teacher, she said, "that will be a breeze. It will be different having a person in the room, but I've experienced so much of being observed that that will be old hat!"

In conclusion, she indicated that she had mixed feelings about this method of supervision in the beginning, but by the end of the semester she liked it and was pleased she had an opportunity to participate in the project.

The cooperating teacher was asked about the effect of the more frequent interaction with the university supervisor, her perceptions of the student teacher's reactions, advantages of being able to view the taped lessons, the impact of the system on her role as a cooperating teacher, advantages and disadvantages of using the MINX in the supervision process, and her perceptions of the presence of the equipment on the behavior of the students.

The cooperating teacher found the frequent contact with the university supervisor to be helpful and said it felt "like we were always in close contact with you." She believed that the frequent contact resulted in an open, trusting relationship among the three individuals involved.

When asked about her perceptions of the effect of the use of the system on the student teacher's experience, she stated, "In the beginning I thought it was a little stressful for her, but I don't believe it was at the end." Advantages of the student teacher being able to view the tape of the class prior to the post-conference were that "she could see each student, which is difficult when you are up in front, as well as all the little things that are going on in the classroom. She could see her mannerisms and how she interacted with the class better than when she was actually in front of the class."

The system's impact on the cooperating teacher's role was that "it made it easier for me knowing that we had such close contact with you and I felt that you were in on everything that was going on all semester." The only disadvantage she mentioned in use of the system was the stress factor. She indicated since the student teacher was going to be taped, it caused her to want the class session to be as perfect as possible. The cooperating teacher thought that the system had little impact on the behavior of the students. She was enthusiastic about her experience using the MINX and other possibilities for using the system in the future.

The university supervisor in this project had had over 25 years of supervisory experience using the traditional format of bi-weekly visits to the school. Perceptions of the differences in the supervisory process using the integrated communication system vs. the traditional school visits were numerous. The increased frequency of contact with the student teacher and cooperating teacher strengthened the relationship among the members of the triad and resulted in a more collaborative effort. This resulted in the type of trust-building that Richardson-Koehler (1988) stated was lacking when limited time was spent in the classroom. In comparison to the traditional model, the supervisor was more aware of the total teaching experience and of progress being made (or not made) by the student teacher. "I really felt a part of the team for the first time in my many years of supervising student teachers. Going back to using the traditional model after using the integrated communication system, I feel as though I have lost touch with the student teacher/cooperating teacher team. It seems as though I am going through the motions without being an effective member of the triad."

The university supervisor also indicated that it was possible to see more of the classroom on the monitor than is often possible when sitting in the back of the room as an observer. In addition, the opportunity to view the tape of the class session more than once enabled the supervisor to focus on different aspects of the teaching act. She believed this provided a more complete assessment of the student teacher's performance than is possible when observing in the classroom setting.

Questions that guided the evaluation of the effectiveness of the use of the integrated communication system in the supervision of student teachers were as follows:

1. What are the advantages of using an integrated communication system for the supervisory process?
2. What are the disadvantages of the system?
3. To what extent is the system technically adequate for supervision?
4. What impact does the use of this system have on the way the university supervisor uses supervision time?

What are the advantages of using an integrated communication system for the supervisory process? The university supervisor was able to contribute more effectively to the student teacher, cooperating teacher, and university supervisor triad than is often possible in traditional supervisory situations. This was due to more frequent contacts with the student teacher, the ability to observe live or taped class sessions in all courses taught by the student teacher, the ability to view class tapes several times giving attention to different aspects of the teaching act, and the ability to observe consecutive classes from the same course. Another advantage was the opportunity for the pre-conference with the student teacher that is frequently not possible in traditional supervisory practices.

The student teacher was able to more carefully analyze the classes taught because tapes of the class sessions were available for review and reflection prior to the post-conference. The frequent supervisory sessions also provided more opportunity for the analysis of teaching than is often possible in traditional methods of supervision. In addition, the student teacher commented that the frequency of contact provided reassurance that "we are all in this together." She also believed that the MINX was less intimidating than having a supervisor in the room. The frequent observations, in her opinion, prepared her for the observations that will occur during the initial teaching experience.

An advantage for the cooperating teacher was that the frequent interaction with the University supervisor resulted in a more collaborative effort in working with the student teacher than often occurs in traditional supervisory practices. Of most importance, use of the integrated communication system strengthened the interactions among the teacher educator, cooperating teacher, and student teacher resulting in an open, trusting relationship due to the frequency of contact.

What are the disadvantages of the system? The disadvantages included occasional technical difficulties and inability to hear all of the student comments. The cost of the interactive communication system and the cost and availability of linkage systems are additional limitations.

To what extent is the system technically adequate for supervision? The MINX camera provides an acceptable view of students in a standard classroom; an auxiliary camera can be attached to view students or activities too far from the MINX to be adequately seen. The teacher can be heard without difficulty although some student comments are lost.

What impact does the use of this system have on the way the university supervisor uses supervision time? The time spent by the university supervisor was used in observation, analysis, and conferencing rather than in travel. Thus, the impact was on the reallotment, rather than the amount, of time spent in the supervisory process. In contrast to having to wait several hours in the school setting before a conference could be held, it was possible to schedule the conference at a time that was convenient for all concerned.

Summary and Recommendations

Since the integrated communication system has been found to be an effective vehicle for the supervision of student teachers, numerous applications are possible if the necessary means of linking the sites are available. The total teacher education program at a college or university could be revamped and revitalized to revolutionize the supervisory process used in the supervision of student teachers and improve the quality of classroom instruction provided in the public schools through the use of an integrated communication system. In addition to the necessary funding for communication and linkages systems, commitment and cooperation of administrative personnel, teacher education faculty, and support personnel is imperative if change is to occur. The collaborative efforts of college/university and public school personnel could improve the quality of education. University supervisors could become more active participants in the supervisory process. It is recommended that an integrated communication system be pilot tested with a school that has four or more student teachers during a semester. The logistics involved in using multiples of student teachers, cooperating teachers, and university supervisors could be resolved before the number of sites was increased.

One application could be with beginning teachers and their mentors as a means of strengthening the linkage between teacher educators and secondary teachers. This would allow the teacher educator an opportunity to follow-up on students in their first year in the teaching profession. Weaknesses in the preservice program could be more readily identified and the feedback from the beginning teacher and their mentors would be invaluable in program evaluation. This networking could serve as a support service to public school personnel.

Other networking possibilities using an integrated communication system could be among the beginning teachers, those teaching similar courses, mentor teachers, with teachers who have been identified as outstanding; among teacher educators; and between state department of instruction personnel and teacher educators. This would help respond to the teacher isolation concern expressed in the literature.

Providing inservice education for teachers in distant locations at the same time the same class is being taught on campus via an integrated communication system is another possibility. This could be a benefit to teachers who live a distance from campus and could not drive to campus in time to attend a class. It would allow all of the students an opportunity to interact even though miles apart. It would be more cost effective than having University personnel travel to the off-campus site or having the teachers travel to campus for all instruction.

It is recommended that continued use of this type of system be explored and expanded if for no other reason than for supervising student teachers. It is an effective method that has advantages for the student teacher, cooperating teacher and university supervisor.

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APPLICATIONS OF INFORMATION TECHNOLOGY IN NURSING

by

Nitya L Karmakar

ABSTRACT

Computer Technology plays an important role in the nursing profession. The paper describes how computerised information systems help nurses monitor the quality of care, manage and evaluate nursing services.

The nursing profession is now entering a technological era. The various aspects of computer applications in nursing are discussed. The computer helps in optimal nursing care in most cost effective ways.

As we approach the year 2000 it is vital to use this new technology more efficiently to educate and train our nurses, incorporating up-to-date software packages in our teaching curriculum.

APPLICATIONS OF INFORMATION TECHNOLOGY IN NURSING

by

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INTRODUCTION

The computer is an integral part of everyday life to-day. It has created an era in the production, processing and transfer of information. Advancements in educational technology and microcomputers have created a technological revolution. Reduced costs and increased availability of computers have caused a general social acceptance of this technology.

Computer technology is modernising the nursing profession also. It has become an inherent part of patient care in all health care settings. Nursing, long recognised as a caring profession, is encountering a technological challenge.

Extensive computer education and research in nursing are well established in U.S. universities and clinical establishments. During the bibliographical search the author could not locate a single Australian nursing educator who had completed any significant work on applications of computer technology in nursing. Computer education should have an important place in nursing curricula of Australian universities. The impact of information technology on health care delivery must not be ignored. The nursing curriculum needs to be reviewed very urgently to prepare our nursing students for the 21st century.

Information collection and use have long been associated with nursing. Florence Nightingale, for example, collected and analysed data about deaths in British military hospitals to show that many of the deaths were unwanted and that the sanitary reforms she put in place in military hospitals had a direct impact on mortality rates **(Aiken, 1988)**

Several authors have described the need to provide computer training to future nurses. **Robinson (1982)** emphasises that computer literacy must be considered among the objectives of a liberal education in all colleges and universities. **Happ (1983)** pointed out that nurses should campaign for instruction, access, and time to familiarise themselves with computers.

Hassett (1984) believes that computer technology is here to stay and that nursing educators must lead the way in familiarising others in the profession with its applications. **Chang (1984)** stated that the education of nurses should include increased experience with computer use and information management. **Andreoli and Musser (1985)** emphasise that nursing leaders must take an informed position in negotiations with hospital personnel in evaluating computer programs that affect nursing care.

Walker (1986) stated the potential impact of computer technology on the nursing education environment. **Soya** and **Lentz (1987)** describes the development of a computer users course for student nurses in a large metropolitan hospital. **Staggers (1988)** points out that computers offer many benefits for nurses including improved accountability and efficiency.

Delaney (1989) suggests that nurses as individuals and nursing as a profession must use computer technology in a manner than enhances nursing care with accurate monitoring capabilities and improved accuracy and access to patient information. **Summers et al (1990)** describes a method that promotes learning by requiring students to solve a nursing problem, relevant to their practice using available microcomputer software.

Therefore, computer technology must be accepted to enhance nursing education. But reluctance on the part of faculty members to become more knowledgeable about computers hinders efforts to increase the computer literacy of nursing students **(Armstrong, 1983, Fields, 1983; Litwalt et al, 1985, Mikan, 1987 and Ronald, 1981)**. We must overcome this reluctance, because computers are becoming an integral part of life, particularly in education.

NURSING INFORMATION SYSTEMS

The need for nursing information systems has been assessed by experts in recent years. The available clinical systems have been found wanting **(Maritz, 1990)**. The study group on Nursing Information Systems (USA) reported in 1983 six specific functions for which Nursing Information Systems were needed:

1. Patient care, including making nursing diagnoses, setting goals of care, choosing nursing actions, monitoring quality of care, and supporting patient education;
2. Resource allocation, including staffing scheduling and nursing care demand
3. Personnel management;
4. Education for patients, employees and students;
5. Planning and policy making, including reports on care provided resources used, outcomes achieved, nursing care costs
6. Investigations related to nursing research and clinical evaluation **(Study group on Nursing Information Systems, 1983)**.

In addition, this group acknowledged the importance of nurses participating in the automation of health care data and the integration of nursing related data within information systems that were being developed. They also recognised that a critical element to achieving a nursing information system was the need for an agreed-upon definition of the appropriate description of patients and their care. In other words, a clear definition of nursing data and the parameters of such data was needed **(Grier, 1984)**.

Computerised Nursing Information systems (NISs) enable nurses to do the following:

- Document, organise, store and process large volume of data
- Communicate and retrieve information for timely decision making
- Generate aggregated information for quality, cost control, evaluation, and research
- Educate and instruct students about nursing knowledge and skills
- Conduct research to help improve the profession **(Saba, 1986)**

COMPUTER USAGE

The integration of computer literacy skills into nursing curricula is urgently needed for the betterment of our health care system. **Saba and McCormick (1986), Donald and Skiba (1987) and Summer et al (1990)** support the need for nurses to learn the evolution of computer technology, hardware and software capabilities. It has also been suggested that contents should include the applications of computers in the four following areas:

- nursing education
- nursing practice
- nursing administration
- nursing research **(American Nurses Association 1987, Thiele, 1988)**

Nursing has a mission to shape health care in society through conceptualising the future. That future lies on INFORMATION TECHNOLOGIES.

Nursing educators must address the challenges and rethink the total educational environment. Particularly, in nursing usage, there is now a wide range of specialist software packages available covering all aspects of health care **(Software Buyers Guide, 1990)**.

NURSING APPLICATIONS

Applications of computer technology to nursing are countless. We shall discuss the applications separately in the following segments:

A. NURSING EDUCATION
B. NURSING PRACTICE
C. NURSING ADMINISTRATION
D. NURSING RESEARCH

A. *Educational Applications*

There are number of uses of computer technology in nursing education. The following are the major types of computer usage in education

- Computer-assisted instruction (CAI)
- Computer-managed instruction (CMI)
- Computer-based education (CBE)
- Other educational applications
- computer assisted video instruction (CAVI)

CAI is currently used as a teaching method in approximately one-half of the nursing programs in the US **(Hebda, 1986)** Four major types of CAI exist **(Hassett, 1984)**
- problem solving
- drill and practice
- tutorials
- simulations

Several CAI program areas used in nursing are given below:

- Basic nursing skills
- Classic scientific principles
- Physical examination
- Managerial decision making
- Research process
- Practice examinations and test questions
- Authoring system
- In service and staff education
- Patient education **(McCormick, 1986)**

There are three areas where Computer-managed instruction (CMI) benefits education:

- student records
- student rotations
- educational resources.

The major Computer-based education (CBE) system available for nursing education is PLATO (Programmed logic for automatic teaching operations) which offers many programs available for nursing education **(Tymchyshyn 1982)**.

Other educational applications are:

- Expert systems - COMMES (Creighton On-line Multiple Education Service)
- Knowledge synthesizers
- Mainframe patient education systems
- Nurse extenders
- Discharge education plans
- Potentials for home computer **(McCormick, 1986)**.

Examples of Computer-assisted video instructions (CAVI) include the integration of computers with workbooks, films strips, audiotapes, videotapes, disks, movies, and television. An example of this integration is the teaching about cardio-pulmonary resuscitation through the movie **The Breath of Life (Tymchyshyn, 1983)**.

B. *Nursing Practice Applications*

Computers are being used more frequently to document nursing practice in hospitals. A patient computerised nursing documentation from admission to discharge is available. The two basic categories of documentation of patient care are:

- Direct patient care
- Nursing Unit Management reports

There are five components of a discharge care plan

- Admission summary assessment
- Summary of learning needs
- Multi-disciplinary plan
- Medication and procedures
- Summary of patient outcomes that the patient should have achieved during hospitalisation.

Particular nursing documentation applications are related to the type of system used. Ten major areas of nursing related content have been developed for the computer by vendors and are listed below **(Young and Colleagues, 1981)**.

1. Assign/update a nursing careplan;
2. Charge compilations on patients' bill that includes billing for stock items used from the inventory of a nursing unit;
3. Impatient census and census reporting;
4. Recording of nurses' notes and vital signs;
5. Nurse staffing management that includes rosters of available statistical reports;
6. Automatic nursing reminders that include staffing schedule reports or the availability of continuing education classes;
7. Nursing staff rosters that include the maintenance of personnel files, qualifications of nurses, and assignments;
8. Order formatting or order entry for medical orders as well as supplies;
9. Order transmission (e.g. ordering supplies from the nursing station through a terminal);
10. Pharmacy floor stock inventories in order to charge patients for medication used.

C. *Administrative Applications*

There are two main categories of administrative applications

- Nursing service administration information
- Nursing unit management information.

The following are the essential components of a nursing services administration **(McCormick, 1986)**:

1. Quality assurance
2. Personnel files
3. Communications
4. Budgeting
5. Census reports
6. Summary reports
7. Forecasting and planning.

The essential components of nursing unit management systems are:

1. Classifications
2. Staffing based on acuity
3. Schedules
4. Inventory
5. Patient bills/charge compilations
6. Incident and other reports
7. Shift reports

The following unit reports can be generated with computers

- Incident
- Poison control
- Allergy and drug reactions
- Identification of patients at risk
- Infection control.

Hospital Information System (HIS) provides approximately 150 functions for administrative information (**Young and Colleagues, 1981**). A few of them are:

- Newborn registration with mother's data
- Patient database
- Emergency room roster
- Retrieve/update housekeeping bed records
- Intensive care patient monitoring
- Nurses meeting schedules
- Telephone list for nurses
- Nursing staff rosters
- Discharge care plan
- Medication instruction
- Radiation therapy management
- Surgery scheduling
- Computerised poison identification
- Message exchange
- Personnel profiles
- Training and education reports

Many other administrative applications are available on microcomputer. A NURSystem available on a microcomputer gives the following 15 administrative and management functions **(McCormick, 1986)**:

1. Personnel profiles
2. Annual holiday report
3. Shift staffing report to plan upcoming shift coverage
4. Attendance report including vacations, sick-leave, holidays
5. Position control that lists vacancies
6. Labour turnover summary
7. Spending rate analysis for previous pay periods
8. Statistical summaries of staffing for 2 weeks including job titles
9. Nursing hours/patient day comparisons
10. Daily adjustment summary (overtime)
11. Daily staffing reports
12. Daily activity reports
13. Daily staffing adjustments
14. Adhoc schedules
15. Tour of duty schedules.

The following reports are generated from this system:

- Patient classification
- Nursing hours per patient day
- Advance duty schedule
- Position control
- Employee attendance
- Monthly spending rate analysis
- Employee profile
- Labour turnover statistics.

The following are the other important microcomputer applications **(Janna Medical Systems, 1983; O'Donhue and Ramshorn, 1983)**:

- Janna +
- Micro-budget systems
- Micro-planning systems
- Micro-personnel systems
- Automated nurse staffing
- Office systems (ANSUS).

The computerised applications have offered several benefits to nursing administration as discussed above.

D. *Research Applications*

The two main applications of computers for nursing research are:

1. Nursing research process
2. Clinical nursing research

The following are the six major uses of computers in the nursing research process **(McCormick, 1986)**:

- Information retrieval
- Data processing
- Statistical analysis
- Graphic displays
- Database management systems
- Text editing.

A computer can be used in nursing research for searching the literature. As many as 6000 to 7000 scientific papers are written each day and knowledge is expected to double every twenty months in this decade. It is anticipated that 5 years after a person is graduated from an university, about 50% of the knowledge he or she has acquired will be obsolete. **(Naisbitt, 1982)**. This huge information database must rely on computers for literature organisation and retrieval. The depth of knowledge a nurse needs exceeds the time available to read and synthesize the literature. The computer can synthesize and search specific literature.

The following are the computerised document retrieval systems that yield bibliographic references.

- Medical Literature Analysis and Retrieval Systems (MEDLARS)
- Medical Literature Analysis and Retrieval System on Line (MEDLINE)
- Excerpta Medica
- Special List Nursing/International Nursing Index (INI)
- Educational Resources Information Center (ERIC)
- Social Science Search (SOCIAL SCISEARCH)

Among all systems mentioned above MEDLINE database is probably the largest document retrieval system in the world. It currently contains approximately 6 million references to biomedical Journal articles and books **(NLM Fact Sheet, 1983)**. It is used to produce three major health indexes: Index Medicos, the International Nursing Index (INI) and the Index to Dental Literature **(Lancaster, 1978)**. It also contains references to 23 of the most widely used nursing journals (International Nursing Index, 1983).

Three general purpose statistical software packages are used in nursing research also. They are:

- Statistical packages for the social sciences (SPSS) **(Hull, 1981, SPSS PC)**
- Statistical Analysis System (SAS) **(Helwig, 1979)**
- BMDP **(Dixon and Colleagues, 1981)**

Nurse research can collect information to facilitate clinical nursing research with the help of Information System. One such system is retrieval through DATAPAC from the University of Alberta, Canada. It provides information on current thesis and nonthesis research in Canadian institutions by telephone. Information for the system is derived from ten cooperative institutions **(Canadian Nurse, 1978)**.

A research taxonomy information available from hospital information systems (HISs) or minicomputers can be divided into three categories **(McCormick, 1981)**:

- Nursing science in patient care data
- Efficiency of nursing strategies in solving patient problems
- Nursing care organisation and delivery

Since information is the lifeline of a clinical nursing research unit, Hospital Information Systems (HISs) and microcomputers have been used to store information for clinical research, Microcomputers have specific advantages in a research unit because of their reduced cost, 'user friendly' capabilities and easily availability of supporting software packages.

CONCLUSION

Across the country, universities should debate how best to use computers in their curricula. We are lagging behind other western nations especially the US in introducing computing in nursing curricula. Computing subjects in nursing course are limited to few Australian universities and the course contents are not sufficient to meet the needs of the present day nursing profession.

Although computers are taking an increasingly important role in the health professions, many nurses are either unaware of the growing impact of information technology or actively resisting involvement with computers as experienced by the author and also supported by a study by Jacobson (1989).

This is due to the fact that they learn very few computer skills during their study and training. The author suggests that computing should be incorporated into nursing curicula at all Australian universities as a compulsory subject. There may be strong resistance from the faculty members to accommodate this new subject. We can introduce this subject in lieu of some of the subjects which may not have much practical use in the nursing profession.

Recently nursing students have complained about their course structure becoming too Academic (The Australian, Wednesday, December 19, 1990 Page 15, reported by Diana Thorp). The computing should be taught over a year at least 2 hours/week. The subject should include fundamentals of computing and uses of integrated software systems (Word Processing, Spreadsheets and Database Manager). The students should be taught how to solve the practical nursing problems.

Many first time users find it hard to learn computer technology. To overcome this anxiety, it is suggested this subject should be taught over a year. It would be exciting to students as they began to link microcomputer hardware and software capabilities to solve nursing problems.

Microcomputer use to solve many nursing problems would be an important first step for nursing students in learning the many possibilities of information technology in health care. Nurses need computer knowledge and skills to prepare them better for their profession both for today and for tomorrow.

As a result of the emergence of new technology the nursing curriculum will require restructuring. Leaders in nursing education must be futurist and visionaries, recognising the impact of computer technology on both fronts: education and health care.

Nursing literature has outlined many benefits of using computers in nursing, including improvements in accountability and efficiency (**Staggers, 1988**). The patients will be benefited because of the improvements in the quality of the care.

As we approach the year 2000, it is expected that the challenge in health care delivery will change and thus the previously successful responses must also change (**Romano, 1990**). Florence Nightingale cautions us that no system lasts that does not advance. We need to march into the next century with acknowledgement of the need for technical, social and organisational innovations which are prerequisites for survival in our health care system. Therefore we should prepare our nurses for the future so that they are comfortable with the unexpected or new technological challenges.

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DEVELOPING A REMOTE SENSING *COMPUTER ASSISTED LEARNING* PACKAGE

by

Gail Kelly
and
Greg Hill

ABSTRACT

The Remote Sensing Programme of the Australian Key Centre in Land Information Studies has successfully developed two Computer Assisted Learning (CAL) modules on remote sensing. The absence of any basic CAL products or text books of interest to high school students, tertiary students and professionals alike, on the topics of remote sensing prompted the design of a CAL product. It was decided to initially produce two of six modules and assess their educational and commercial viability.

The modules were developed in association with the Computer Assisted Learning Unit of The University of Queensland using a multi-skilled team. The two completed modules have proven successful and are being used nationally and internationally. The development process has been streamlined and the optimum design programme for a remote sensing product established.

DEVELOPING A REMOTE SENSING *COMPUTER ASSISTED LEARNING* PACKAGE

by

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CONCEPT BEHIND DEVELOPMENT

The science of remote sensing has become of interest to a wide variety of disciplines (e.g. agriculture, hydrology, geography, climatology, forestry, etc). However, in many of the tertiary education institutions, the staff and/or library resources are not adequate or available to support courses in this field even at the introductory level. In the high school system, where there is a need to introduce this new technology, that impacts on everyday life (e.g. satellite pictures of weather patterns), there is little or no material or expertise available.

Another educational problem is that user disciplines (e.g. geology, agriculture) are dominated by professionals who were trained before the advent of "remote sensing". These people need to update their knowledge if they are to gain the benefits of the new technology. The general interest that exists in the science of remote sensing has an impact on remote sensing practitioners. Practitioners are faced with a high demand for training programmes and seminars on the topic. One drawback from this educational demand is that many remote sensing experts have little background in education and do not devise successful teaching programs.

Existing literature on the topic of remote sensing has several disadvantages. Firstly, many of the books are not basic enough for non-technical people as they are designed primarily for university students. Secondly, some basic teaching packages are difficult to manage. For example, standard teaching kits comprise slides, audio cassettes, booklets and ancillary transparency materials. Various components of these are frequently lost by teachers and students and the quality of the materials soon deteriorates. Both factors make the kits unusable in the long term.

The concepts of remote sensing are relatively new and the field relies heavily on analysing graphical products. Therefore, students often need time to revise work sessions. These factors and the others mentioned previously all favour a CAL approach to introducing remote sensing.

It was decided, therefore, to design a product suitable for a wide range of users. As remote sensing is such a visual subject and the digital data are suitable for computer presentation, a product with an emphasis on the visual explanation of concepts via computer graphics was chosen. One consideration was that the product should have appeal in foreign countries where English was not the first language. Another aim was to produce a package which was useful to a range of disciplines.

METHODOLOGY

A flow diagram by Roblyer and Hall (1985) was found to succinctly describe the entire process of designing CAL products. This diagram (Figure 1) outlines the three phases involved:

Phase 1 - Product Design
Phase 2 - Preprogramming Development
Phase 3 - Development/Evaluation

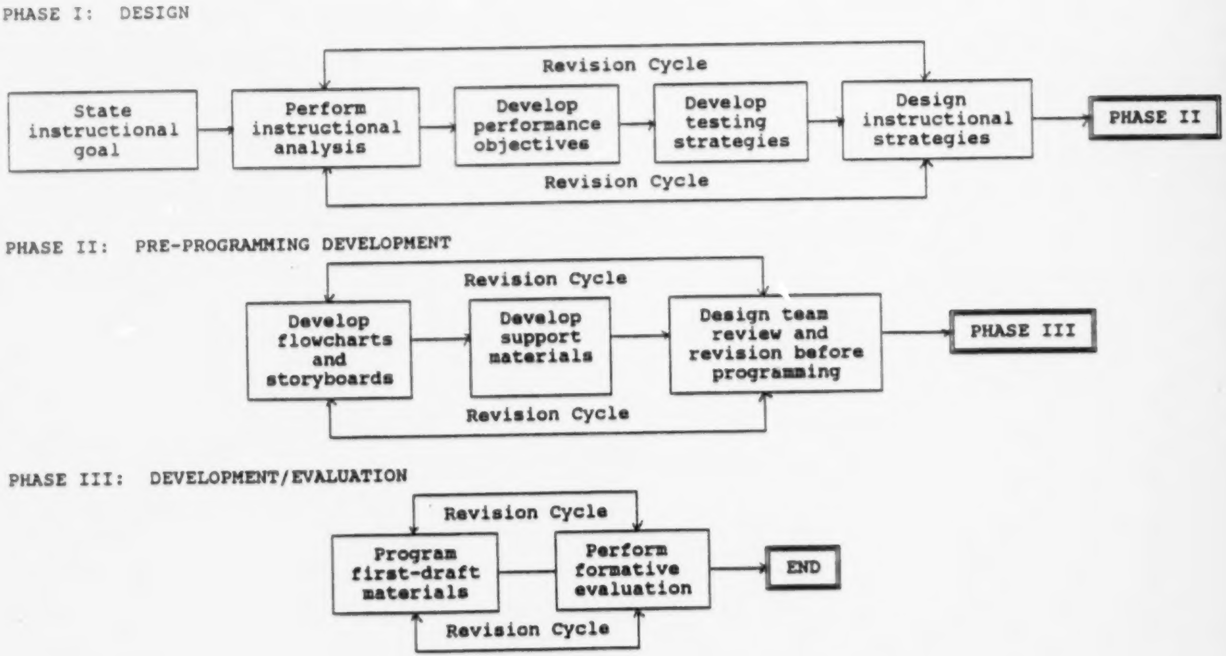
Phase 1: The remote sensing CAL modules were designed around course materials and syllabi developed for formal and training courses in remote sensing (e.g. Kelly and Hill 1988, Hill and Kelly 1989). The first task was to assess the structure of existing notes and appropriateness of diagrams, overheads, slides etc. for transfer to a CAL format. Following this overview the text was drafted and simplified. Numerous graphics were designed to reduce the volume of text. A balance was reached where text and descriptive graphics complemented each other. The text was then assessed by an instructional design team. This resulted in identification of over or under simplified matters and suggestions on the presentation and amount of information for each screen. These changes were discussed amongst the developers and modifications then made to the text and graphics. A range of options regarding style and form of presentation were identified for final assessment at a later stage when the team was fully conversant with the potential of the authoring and graphics systems being utilised. The overall concept for the initial modules was now in place.

Phase 2: Text and graphics were then put in the storyboard format (i.e. paper based screen mockups) and animation comments for the graphic artist finalised. Producing the storyboards for every screen illustrated the need for changes to the sequence of information in some cases. Satellite images were selected at this stage and processed down to 16 colours. Mastering this task (i.e. reproducing images of acceptable quality from so few available colours), was crucial to the final form of the CAL product and its success as a stand alone educational package.

The storyboards were then assessed by an education/instructional design referee and several technical/remote sensing referees. In light of their comments the material was modified. The next step involved the completion of the illustrative material (by the graphic artist) and the programming of the text using the Tencore authoring package.

Phase 3: The modules were then entered in CAL format. Interplay between the authors, programmer and graphic artist led to subtle and not so subtle changes to the original storyboard screens. Experience with the authoring system, in some cases, led to more

Figure 1 - The Courseware Design Model
(Roblyer and Hall 1985:14)


PHASE I: DESIGN
Revision Cycle
State instructional goal
Perform instructional analysis
Develop performance objectives
Develop testing strategies
Design instructional strategies
PHASE II
Revision Cycle
PHASE II: PRE-PROGRAMMING DEVELOPMENT
Revision Cycle
Develop flowcharts and storyboards
Develop support materials
Design team review and revision before programming
PHASE III
Revision Cycle
PHASE III: DEVELOPMENT/EVALUATION
Revision Cycle
Program first-draft materials
Perform formative evaluation
END
Revision Cycle

sophisticated screen presentations (particularly with graphics) and in others to abandonment of preferred formats. When the project team was satisfied with the final product, arrangements were made for the product to be reviewed by a variety of people (i.e. technical experts - remote sensing and education, potential users - university undergraduates, government technical officers and high school students/teachers). Both groups made suggestions. The project team assessed the usefulness/validity of comments and the feasibility of incorporating each into the package. With the package complete, the remaining stage was to finalise the documentation to accompany the floppy disks.

One aim of the CAL product was to make it user friendly to ensure paper based documentation could be kept to a minimum, hence reducing the likelihood of the absence of documentation affecting the usage of the product. The product documentation gives standard instructions on loading the software etc. and introduces the user to features of the package. Instructions are also provided to explain the student usage information which is automatically recorded. In instructor's mode, special records are accessible on each student's performance in the assessment section, along with general usage statistics (e.g. module/s usage/completion, total cumulative time, date of last session, number of sessions of use, etc). The documentation also instructs teachers on how they can utilise the assessment section for student self assessment or formal assessment.

LESSONS LEARNT

A number of important lessons were learnt:

- Authors having no previous CAL experience need to gain an understanding, however basic, of the process involved before work begins. Reading the literature, reviewing CAL products and talking to technical persons involved in the field prepares the developer for the task of translating ideas and materials, via a team of specialists, to a quality CAL package.

- Design of a CAL package would appear to demand very large inputs of time and energy. These would appear to exceed the most pessimistic estimates of optimistic project teams. As it is not really possible to assess consistency of style, graphics, format and so on until the product is in CAL format, revision becomes a particularly time consuming task.

- A multidisciplinary team provides a good "wall" off which to bounce developmental ideas. Having a mixture of people familiar and not familiar with the technical content ensures that all concepts and technical aspects are clearly explained. In a field like remote sensing a delicate balance must be struck between simplicity of explanation and the rules and conventions of science. The team approach copes with the problem and provides support when suggestions/criticisms are provided by referees/users.

- Use of storyboards is essential to ensure all team members are aware of the sequence of events in the lessons. In CAL, every screen is important and requires attention. Hence, using storyboards for each screen is very useful to ensure that nothing is missed.

- A thorough evaluation of the proposed authoring system is required to ensure it can do what is required.

- As with all projects, the more organised the team the faster results are achieved.

- "Road- testing" the final CAL product on a range of people provides, in some cases, interesting and often surprising results. In many cases one does not foresee the range of user competency in computer use, user responses or how instructions or questions are interpreted.

PRODUCT OVERVIEW

The final product comprises two modules, *What is Remote Sensing?* and *Spectral Signatures*. Each of the modules consists of 7 topics, and 1 exam which can be used for formal or self assessment. Table 1 is an abbreviated table of contents for modules 1 and 2.

The modules are user friendly and available in English. Numerous colourful and animated graphics, in addition to satellite and aircraft imagery, are used in each of the modules.

The user records can be controlled by an instructor and are password protected. The lessons can be stopped at any time, while recording every user's accumulated time and assessment performance.

The product was produced for IBM compatible PC systems with EGA graphics capability. This way, systems with both EGA and VGA graphics cards can be utilised. As remotely sensed data are often displayed from a possible range of 16 million colours, the EGA route of 16 colours would appear to be the minimum standard possible for useful presentation of remotely sensed imagery.

Each module of the series is a stand alone product capable of being run on a personal computer with the following features: IBM PC or clone; EGA or VGA graphics board; colour monitor and hard disk.

POSTSCRIPT

Since their launch in May 1990, the remote sensing modules are being used both nationally and internationally in educational, government and research institutions.

In 1990 the product received two awards:

- Australian Society for Educational Technology - *Non-Video Media Award*; and

- BHP Engineering and Australian Institute of Cartographers - *Technology Research and Development Award*.

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TABLE 1 - TABLE OF CONTENTS FOR MODULES 1 AND 2

Module 1 - What is Remote Sensing?

Topic 1 - The Science of Remote Sensing
2 - Data Capture and Analysis
3 - Remote Sensing Information Types
4 - Passive and Active Remote Sensing
5 - Scanner and Camera Systems
6 - Physical Processes of Remote Sensing
7 - Energy, Space and Time in Remote Sensing
8 - Assessment of Understanding

Module 2 - Spectral Signatures: Vegetation, Soil and Water

Topic 1 - Introduction
2 - What is a Spectral Signature?
3 - Identifying Vegetation, Soil and Water
4 - Spectral Characteristics of Vegetation
5 - Spectral Characteristics of Soil
6 - Spectral Characteristics of Water
7 - Applications of Remotely Sensed Data
8 - Assessment of Understanding

TAKEAWAY COURSEWARE

by

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ABSTRACT

Students increasingly have their own computers at home. Takeaway courseware frees up their study location options. We explore the reasons for providing such takeaway courseware for Information Technology subjects. We also look at some of the courseware developed during the course of a DEET funded project. Future interactive courseware platforms and the changes they will bring to our development options are discussed.

How can we harness the power of information technology to enhance the learning of our students? This was the focus of a DEET Reserve Fund project conducted during 1990 at the Faculty of Information Technology, Queensland University of Technology. One of the areas of interest for us is "takeaway" courseware.

WHY TAKEAWAY COURSEWARE?

A survey conducted in 1990 indicated that the takeaway aspects of our current Computer Managed Learning (CML) system is attractive to students. The statement *I like being able to take the question printout home to work on it whenever and wherever I wish* received the highest agreement ranking among all the questions presented to our CML students. The statement *I would prefer to have a printed copy of the questions and answers to use for later revision* received even higher agreement ratios from our students who had experienced the CBE facility. (Willie, et al.,1991)

The CML system is available on campus 24 hours a day, 7 days a week. Students are issued a personalised set of questions. They choose their own time and place to answer the questions, then enter their answers back into the system. A summary of their performance on those questions is issued by the system, giving the student immediate feedback on their progress. The availability of the system on an around the clock basis and over the weekends means students are not constrained in choosing a time to draw a tutorial or enter their answers.

CML can also be accessed over the telephone lines with a modem. Students with a modem can both draw their tutorial and enter their answers remotely. They currently must pick up their printouts on campus. As all students attend campus lectures, this is not a significant problem.

As the takeaway aspects of the CML materials are valued by students, one aspect of our research was investigation of other software packages which expanded our options for delivery of take away interactive computer learning materials. We focussed on systems which provide royalty free distribution of copies of our developed courseware to our students.

We have created interactive computer based courseware using each of the three tool paradigms cited by Leiblum (1988,141): general purpose programming language, special purpose authoring language and authoring systems. We will look at their differences in some detail later.

HYPERTEXT, SIMULATIONS AND VARIATIONS ON THE THEME

Our objectives for the courseware are to

- involve the learner, persuading him or her to become an active participant;
- give the learner some control over the progress of the session;
- (hopefully) expand the experience and/or knowledge of the learner.

The courseware we developed uses hypertext, animation and simulation techniques together with graphics and text. Simulations are used to provide the student with practical experience associated with concepts which previous students found difficult to master. This courseware is designed to be used both in the classroom for demonstrations and by the student during their study time.

We also found hypertext (in various forms) very useful in allowing the students to explore the knowledge in their own way. People do not deal well with information presented in list or linear form. Hypertext allows the user to explore material in a manner which suits them. The term *hypertext* was coined by Theodor Nelson in the 60's to describe the ability to link words or phrases with other explanatory material in a non-linear fashion. The other materials may provide detailed explanations or be information which is cognitively connected.

A recent article noted that:

> *The advantage of hypertext becomes evident when you consider the inherent disadvantages of the traditional information medium — the printed page. The presentation of information in written form is explicitly linear. ... Hypertext retains the capacity for the high information content provided by print media, but removes contextual limitations. ... This means that rather than having to follow the explicit course of a document, the user can choose to explore an exponential area of contextual alternatives. In other words, the user is free to explore any information path in the document.* (Gessner, 1990)

The educational potential of hypermedia was summarised by Hooper in 1986 as follows:

> *The interactions of hardware, software and interface innovations can provide for some long-lasting and solid changes in educational environments. Changes in scale of information, in the tools for information manipulation, in the cost of widely distributed data bases, and in*

the "appearance" of information, promise revolutions in the human processing of information; education can focus on human thought and thoughtfulness in a range of media, and defocus from the memory of textual facts as the current very new potentials are realised.

Exploratory learning is promoted by hypermedia delivery although the learning materials must cater for the problem of *getting lost in hyperspace*. Maps and optional guides are proving helpful with this problem. Hypermedia systems were originally developed on large mainframe computer systems and were available only at high cost on a limited scale. Technical changes have altered this and hypermedia shells are increasingly available at reasonable cost. The technology now can deliver an affordable educational tool both in terms of software and development time.

DEVELOPMENT RESOURCES

The Researcher and Research Assistants on the project were drawn from Staff and students in the Faculty. As such, all had competence in programming computers. Thus we did not encounter many of the well documented problems which general purpose programming languages present to the computer novice. Authoring languages such as cT provide certain capabilities which would need to be separately developed in a general purpose language. However, a modular, object-oriented or library approach to the problem provides the tools to rapidly develop additional courseware.

Authoring systems take this a step further and provide a very high level environment for development. This has aspects of both convenience and inconvenience. One can quickly get a prototype running. However, the authoring system needs to support the instructional design characteristics you want. If this is not the case, the author will need to re-enter the world of programming. Often, a particular problem such as interface to external equipment will not be addressed by the system and a general purpose language such as C will be required. Not all authoring systems support connections to externally developed programs.

As stated previously, we are primarily interested in systems which do not bar free distribution of copies of our developed courseware to our students. With this in mind, we looked for software development resources which resulted in executable programs through compilation or systems which provided royalty-free runtimes or site licensing without numeric restrictions. Materials have been developed using cT (royalty free run-times), Turbo C (compiled executables), the C-Worthy library (royalty free), PCX Toolkit library (royalty free), Hyperties (limited royalty free), KnowledgePro (royalty free), Icon-Author (site licensed), and Toolbook (royalty free). These products also support interoperability with externally written programs. This list of products which meet our distribution criteria is not exhaustive.

COURSEWARE DEVELOPED TO DATE

As part of the development process we have defined a standard base hardware platform. Every courseware product is designed to run on the platform specified in Figure 1.

We feel the standard will be upgraded to include a VGA monitor and graphics card within a few years. We are also interested in future delivery on the Unix workstation platform.

IBM-AT compatible
EGA monitor and graphics card
Hard disk drive
1 Mb RAM
MicroSoft compatible mouse

Figure 1: Standard platform for courseware delivery

Leiblum (1988) developed a cataloguing system for commercially available courseware. We have loosely based the following descriptions on the relevant portions of his checklist. Courseware produced includes:

Cipher Simulators:

Purpose/Learning Objective: This is courseware, developed using cT, for a faculty subject in Data Security. It explains the 3 modes of operation of the Data Encryption Algorithm. These are Cipher Block Chaining, Cipher Feedback and Output Feedback. Figures 2 and 3 illustrate two of the encryption modes simulated in the courseware. The user is provided with explanatory materials when they point to different portions of the illustration. Figure 3 shows an example of this where the user has pointed to the Encryption box.

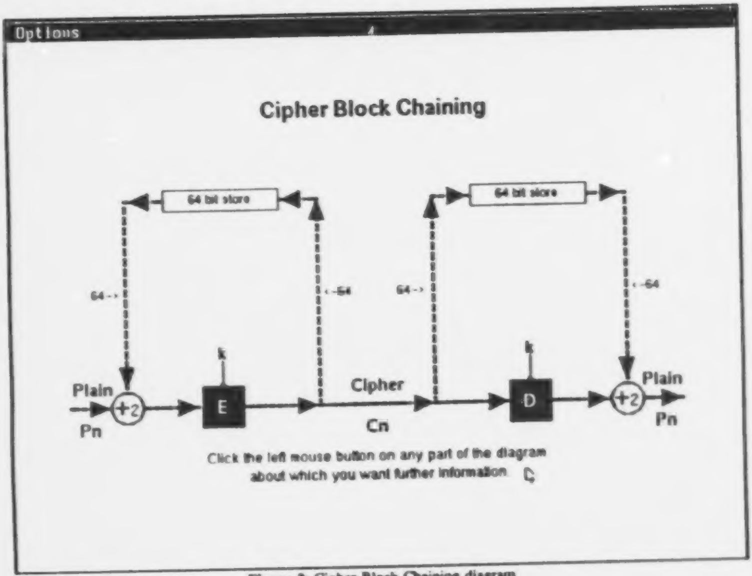
Audience: This is suitable for introductory subject level.

Potential Extended Uses: Continuing education courses.

Time required by user: 30 minutes.

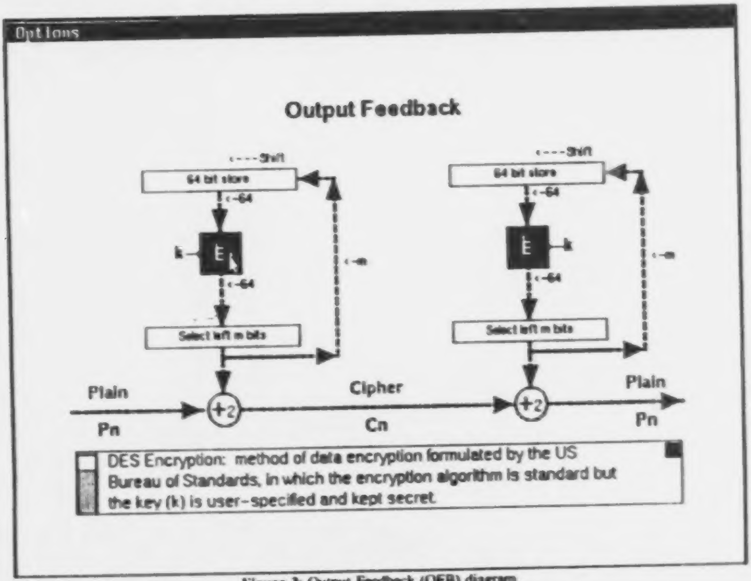
Availability: The executable version was archived onto 1 floppy (360k) containing installation and *readme* files. Copies are available in the Faculty's computer laboratories for the students to take away or use on campus. It has also been installed on the CBE (Computer Based Education facility in the Gardens Point Campus library) for student access.

Distribution: Courseware is freely distributable.


Options
Cipher Block Chaining
64 bit store
64 bit store
64-->
<--64
64-->
<--64
k
k
Plain
+2
Pn
E
Cipher
Cn
D
+2
Plain
Pn

Click the left mouse button on any part of the diagram about which you want further information.

Figure 2: Cipher Block Chaining diagram


Options
Output Feedback
<----Shift
64 bit store
<--64
k
E
<--64
<--m
Select left m bits
<----Shift
64 bit store
<--64
E
k
<--64
<--m
Select left m bits
Plain
Pn
+2
Cipher
Cn
+2
Plain
Pn

DES Encryption: method of data encryption formulated by the US Bureau of Standards, in which the encryption algorithm is standard but the key (k) is user-specified and kept secret.

Figure 3: Output Feedback (OFB) diagram.
Mouse button clicked on left 'E' box.

Pointers Tutorial:

Purpose/Learning Objective: This tutorial is an explanation of pointers in the C and C++ programming languages. It is written in C using C-Worthy (a set of libraries) to display text and to provide the user interface. PCX Toolkit (a graphics library) is used to display graphic (developed using PC Paintbrush) explanations of how pointers are represented in memory. Figures 4 and 5 show a pair of screens from the Tutorial. Figure 4 contains the C Language text. The student can switch between the text and the illustration of the memory allocation (Figure 5) by pressing the F2 key.

Audience: C language students at stages from introductory to advanced.

Potential Extended Uses: Continuing education courses at QUT; distribution to other educators teaching the C Language. Requests have already been received from faculty in Computing Science for similar courseware covering Pascal and Modula 2.

Time required by user: 30 minutes.

Availability: The executable code is archived into 2 disks (360K) containing installation and *readme* files. Beta test copies are installed on staff access machines in both buildings occupied by the faculty as well as on the CBE network in the library.

Distribution: Courseware is freely distributable.

PC Assistant:

Purpose/Learning Objective: PC Assistant, a computer based help/advice system for novice computer users, using hypertext and hypergraphics, was originally developed as an undergraduate student project in KnowledgePro. This courseware has been upgraded to Version 1.1. PC Assistant is now compatible with CGA, EGA and VGA graphics cards. A version which runs under MicroSoft Windows 3/KnowledgePro Windows has also been developed. Industry users have been enthusiastic about both this courseware and the concepts it utilises. Figures 6 and 7 illustrate two of the hypergraphics screens from the PC Assistant. The main Menu in Figure 6 provides the user with an initial guide. The graphic illustrating how to set up the printer in Figure 7 was developed in PC Paintbrush.

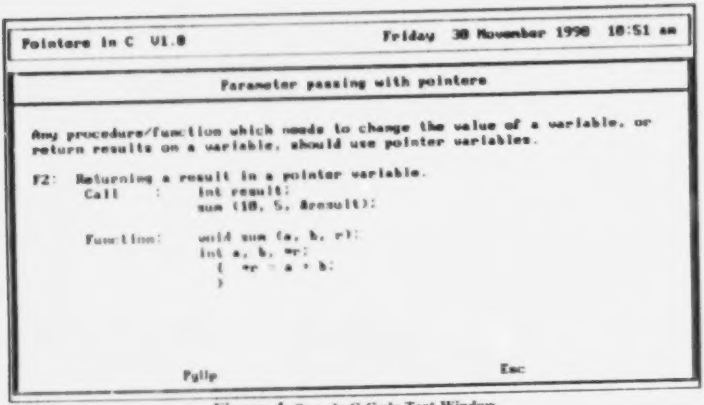
Audience: Novice computer users.

Potential Extended Uses: This courseware has been distributed to outside organisations in Brisbane, Sydney and Melbourne.

Time required by user: 30 minutes.

Availability: The executable version has been archived to 2 disks (360K).

Distribution: Courseware is freely distributable.



Pointers in C V1.0
Friday 30 November 1990 10:51 am

Parameter passing with pointers

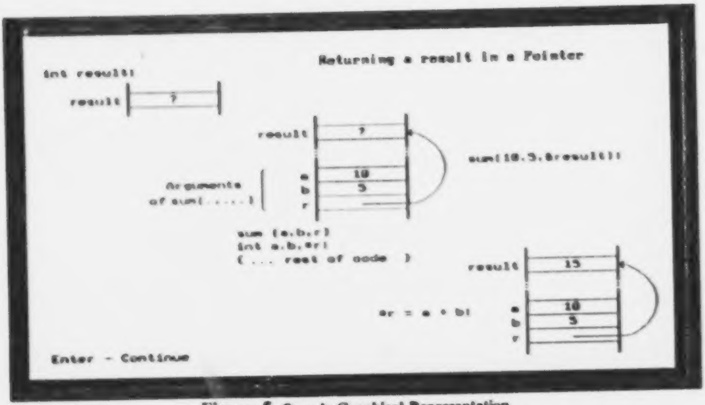
Any procedure/function which needs to change the value of a variable, or return results on a variable, should use pointer variables.

```
F2:  Returning a result in a pointer variable.
      Call      :      int result;
                       sum (10, 5, &result);

      Function:        void sum (a, b, r);
                       int a, b, *r;
                         {  *r = a + b;
                         }
```

PgUp
Esc

Figure 4. Sample C Code Text Window
Returning a Result in a Pointer



Returning a result in a Pointer
result
?
result
?
a
10
b
5
r
Arguments
of sum(.....)
result
15
a
10
b
5
r
Enter - Continue

```
int result;
sum(10,5,&result);
sum (a,b,r)
int a,b,*r;
{ ... rest of code  }
*r = a + b;
```

Figure 5. Sample Graphical Representation
Returning a result in a Pointer

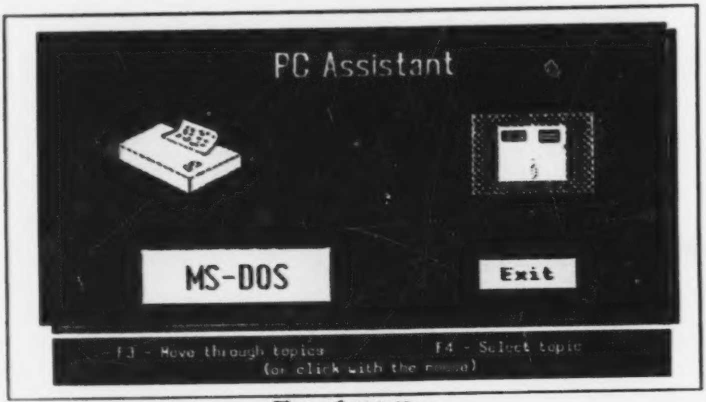
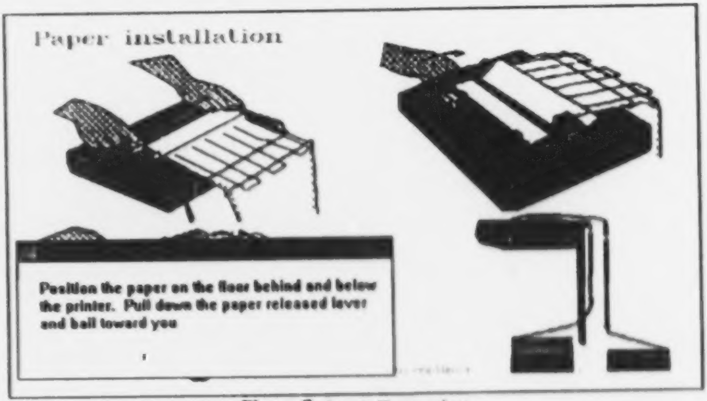

PC Assistant
MS-DOS
Exit
F3 - Move through topics
F4 - Select topic
(or click with the mouse)

Figure 6. Main Menu


Paper installation

Position the paper on the floor behind and below the printer. Pull down the paper released lever and bail toward you

Figure 7. Sample Hyperregions

CML Assistant:

Purpose/Learning Objective: This software provides assistance to students using CML. It was developed with Hyperties, a hypertext tool. Figure 8 shows the main contents screen for the CML Assistant. From here, hypertext links move the user to further explanations. Figure 9 is an example of a graphic in Hyperties. Unlike KnowledgePro, Hyperties does not support linkages from its graphics.

Audience: Students using the CML System at QUT.

Potential Extended Uses: Other centres utilising CBTS/CML or LMS.

Time required by user: 30 minutes.

Availability: This courseware is available on a campus-wide network which can limit the number of users allowed access. Further copies are available in the Faculty's PC laboratories.

Distribution: The license allows free distribution of 20 copies.

Brain Virus Simulation:

Purpose/Learning Objective: This is an animated simulation of which the Brain Virus invading the host computer from an infected floppy disk. cT was used to develop this software. The simulation was developed in conjunction with the Information Security Resource Centre. Figure 10 shows the basic display with the computer's internal memory represented on the left and the relevant portions of the infected disk on the right. As the infection spreads from the disk to the machine, the user can point to different portions of the computer memory and disk and receive a more complete description of the current state.

Audience: Personal computer users.

Potential Extended Uses: Interest in this product is very high among educators. It will soon be distributed to schools with the Grade 11-12 Information Processing and Technology subject as well as to teachers at Queensland TAFE Colleges through the ISRC. Interest has been generated internationally through word of mouth and copies of the simulation have been or will be sent to sites in the U.S.A., New Zealand, and Micronesia. More formal promotion is expected to increase awareness and demand for this product.

Time required by user: 30 minutes.

Availability: The executable code is archived into 1 disk (360K) containing installation and *readme* files.

Distribution: Courseware is freely distributable.

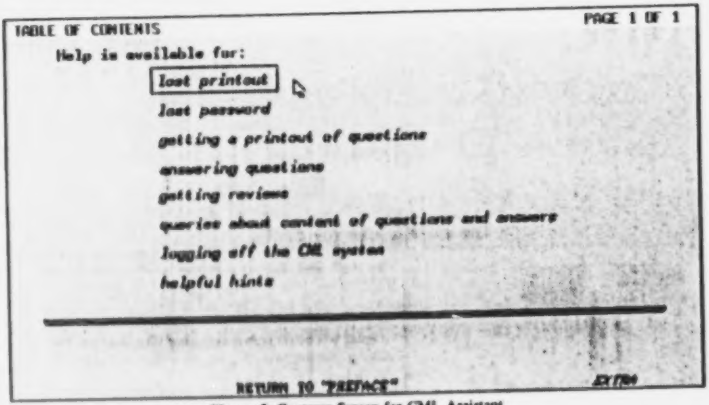


TABLE OF CONTENTS

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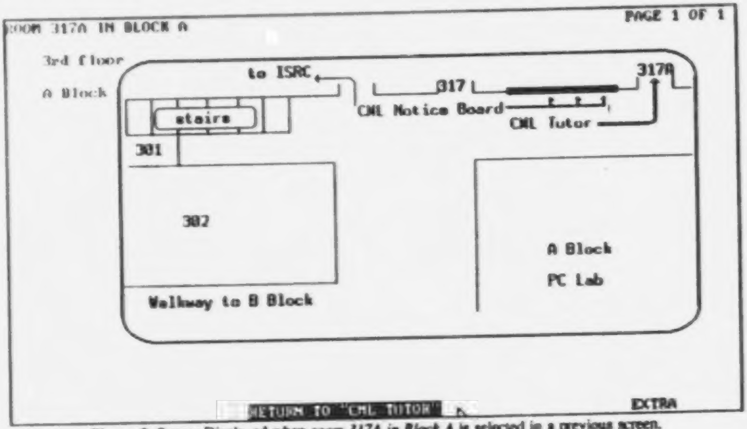
Help is available for:

- lost printout
- lost password
- getting a printout of questions
- answering questions
- getting reviews
- queries about content of questions and answers
- logging off the CML system
- helpful hints

RETURN TO "PREFACE"
EXTRA

Figure 8. Contents Screen for CML Assistant



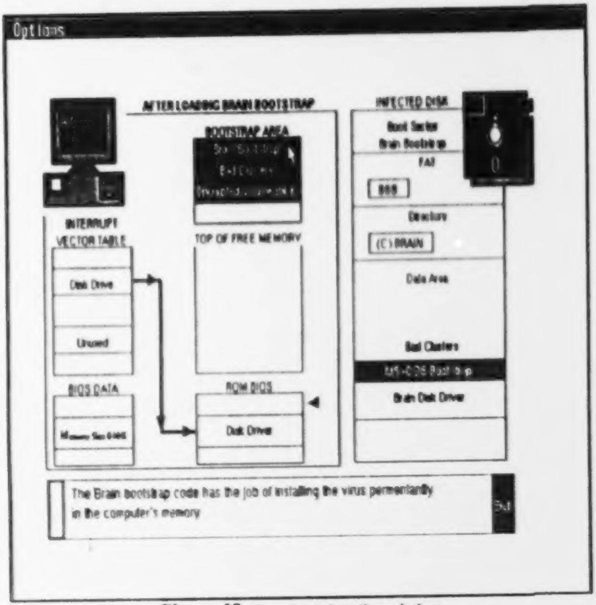
ROOM 317A IN BLOCK A

PAGE 1 OF 1

3rd floor
A Block
to ISRC
317
317A
stairs
CML Notice Board
CML Tutor
301
302
A Block
PC Lab
Walkway to B Block
RETURN TO "CML TUTOR"
EXTRA

Figure 9. Screen Displayed when *room 317A in Block A* is selected in a previous screen.

BEST COPY AVAILABLE


Options
AFTER LOADING BRAIN BOOTSTRAP
BOOTSTRAP AREA
Brain Bootstrap
Bad Clusters
Encrypted
INTERRUPT
VECTOR TABLE
Disk Drive
Unused
BIOS DATA
Memory Size
TOP OF FREE MEMORY
ROM BIOS
Disk Driver
INFECTED DISK
Boot Sector
Brain Bootstrap
FAT
888
Directory
(C) BRAIN
Data Area
Bad Clusters
MS-DOS Bootstrap
Brain Disk Driver
Exit

The Brain bootstrap code has the job of installing the virus permentantly in the computer's memory

Figure 10. Sample explanation window of *Brain Bootstrap*

CURRENT EVALUATIONS

In 1991 we are evaluating other products such as Toolbook, IconAuthor and Owl Guide. These products, and Knowledge-Pro, run under MicroSoft Windows 3 which we expect to be a common platform within two to three years. This platform is now available at limited sites on the Gardens Point campus and most computers purchased by our students in 1990 can support the environment.

FUTURE DEVELOPMENTS

Over the next two to four years we expect the basic delivery computer platform to evolve quite dramatically. We expect to see MicroSoft Windows 3 become common on university and student machines and to see those machines based on microchips like the Intel 80386 or 80486 with colour monitors supporting at least 1000 pixels per row. The computer's internal memory will be much larger than today's standard 640 Kilobytes (Kb), probably in the order to 4 to 8 Megabytes (Mb).

The current storage problem with graphics will be addressed by compression-decompression hardware. As an example, the graphics file for the printer loading graphic, Figure 7, above takes 52 Kb of disk storage. The common 360 Kb floppy disk will only hold 6 such files. Compression hardware now coming on the market has the capacity to reduce this to just 10% of current requirements or approximately 5 Kb. With moving images, the compression reduces requirements to just 1% of the original. Lets look at these latter two developments in more detail.

HIGH DENSITY STORAGE. Storage devices will also increase in capacity. Removable, high density storage media such as 4 and 20 Mb floppy drives, 620 Mb magneto-optical rewritable disks and CD-ROM technologies are now obtainable at an economical price. They are all expected to follow the downward price trend which is traditional in high-technology equipment and media. Their quality and capacity now mean we can provide complete course materials utilising hypertext and even multimedia for students to use at sites away from campus.

An example of current use of CD-ROMs is the QUT Gardens Point Library which has a CD-ROM facility called the Public Access Database facility (PAD). The PAD is proving very popular with students. Over twenty databases are available and the information retrieved can be downloaded to floppy disks for students to take home. Printers are also available for hard copy.

Industry predictions say a CD-ROM drive and a video compression-decompression coprocessor will be included in the next generation of desktop computers.

VIDEO COMPRESSION-DECOMPRESSION HARDWARE. Late in 1989 Intel announced the Digital Video Interactive (DVI) chip-set to enable full moving video images in teaching systems without the need to use either sequential video tape or high-cost video disk. With this technology we can utilise moving high quality images in conjunction with instructional materials without the high cost of remaking video disks.

Within one to two years, this courseware will be economically viable *off-campus* — in the homes of part-time students and consequently in the homes of more remote students and their families. Development of techniques for efficient utilisation of this technological breakthrough will facilitate their transfer to other educational uses such as industrial training and primary and secondary education.

Although the video and sound data is compressed, DVI still requires large amounts of storage.

CONCLUSIONS

Takeaway courseware has proved viable as a method of delivering instructional materials for students in Information Technology. It will be particularly valuable for part time students as they will be able to use the materials when and where they wish. Hypertext and hypermedia show great potential for exploratory instructional materials and techniques such as mapping and an optional introductory guide enhance the usefulness of the approach.

The platform standard is currently a problem, particularly in University settings, but the future will see a windows based, powerful (by today's standards) machine in common use. This machine will support moving images as an integral part of our courseware.

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INSTRUCTIONAL DESIGN EXPERT ADVISORY SYSTEM (IDEAS)

by

Andy Koronios

ABSTRACT

With the significant bottle-necks that exist in the development of Computer Assisted Learning Systems, the increased activity in training due to the Training Levy and the improvement of User Interfaces, an increasing number of content experts will wish to develop their own CAL systems. This is similar to what has occurred with the development of other computing systems and the subsequent genesis of 'End-User Computing'.

It is probable that a parallel development will take place, perhaps called 'End-User CAL'.

Given the above, many are focusing their attention on the development of CAL authoring systems aimed at novice computer users.

I have recently begun development of a prototype expert system which could act as an adviser in instructional design techniques, and will work along side content experts assisting them in the development of CAL projects. This system would act as an expert adviser on many aspects of CAL design such as analysis, synthesis, implementation, assessment of such systems.

The project has six phases viz Preliminary Analysis, Knowledge Acquisition, Knowledge Representation using Expert Systems Development Techniques, Design of the Feasibility Prototype, Implementation and Testing. It is currently in the Knowledge Acquisition phase.

INSTRUCTIONAL DESIGN EXPERT ADVISORY SYSTEM (IDEAS)

by

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Keywords

Computer Assisted Learning, Educational Technology, End-User CAL, Expert Systems, Instructional Design, Knowledge Acquisition, Knowledge Representation, Prolog.

1 Introduction

This paper is a preliminary presentation of a project that begun some months ago, to build an Instructional Design Expert Advisory System (IDEAS) which may act as an adviser for content experts who wish to develop Computer Assisted Learning (CAL) courseware with minimal assistance from instructional designers, computer analysts and programmers.

2 Background

The University College of Southern Queensland (UCSQ) offers courses to students by way of on-campus and distance teaching.

As a distance education provider UCSQ has a distance teaching strategy which includes multimedia self-instructional packages used independently of time and place.

UCSQ has, for several years, been involved in the development of Computer Managed Learning (CML) as well as Computer Assisted Instruction (CAI) systems. The Distance Education Centre (DEC) of UCSQ has recently established an Educational Technology section which is involved with the development of such systems using existing authoring tools.

During the second half of 1990 the School of Information Technology established a Centre of Integrated Information Technologies (CINITEC) consisting of several research groups. One such group's mandate is to conduct research in Educational & Training Technologies.

The development of Computer Assisted Learning Systems currently begins with the 'content expert' preparing the material to be taught. This content expert then liaises with instructional designers and computer professionals who, using CAL authoring packages, prepare each lesson. These are then presented to the content expert who makes suggestions for correcting or enhancing the lesson. This process may be repeated several times before completion of the project and increases the overheads of the production of CAL courseware.

For relatively complex systems, it takes in excess of 200 hours to produce one hour of instruction. With the increased activity in training in Australia and other parts of the world, as well as the constant need to update material especially in certain knowledge domains, it is important to decrease this high development time and consequently the cost effectiveness of CAL development.

The above method of developing CAL is producing bottle-necks at the programming stage. To overcome this problem many content experts are seeking to find sufficiently user friendly software for content experts who may have little knowledge of computer analysis, design and programming.

Many CAL authoring system vendors are responding to this need by providing authoring systems that are very easy to use and designed for use by the content expert, who more often than not, is a computer novice. Two examples of such software packages are Author and Knowledge Pro.

This phenomenon is similar to the evolution of other computer applications development processes. In the past 10 years a large proportion of the development of computer systems has shifted from the 'Computer Centre' to the domain of end-users, i.e. 'End-User Computing'. It is likely that a similar phenomenon is taking place in the development of Computer Assisted Learning Systems, 'End-User CAL'?.

'End-User Computing' has assisted greatly in reducing the development bottle-necks. So too 'End-User CAL' will enable users to, very quickly, create prototypes of the kind of lessons they wish to give to their students. This will obviously reduce the development times and possibly also increase the content expert's commitment to the project, since he or she will have more control of the development process.

However, like End-User computing this strategy will have shortcomings. University & college academic staff generally are appointed to the positions of professors, lecturers and tutors because they are expert practitioners in their field. A large proportion of academics lack both formal qualifications and background experience in instructional design and related fields. It is therefore likely that although these staff members are 'content experts', they may have difficulty in producing effective learning environments, particularlly as many of them have no experience in the development of Computer Assisted Learning Systems.

3 The Development Process of the Instructional Design Expert Advisory System

The project has been divided into seven stages:

- (i) Introductory Analysis & Literature Search
- (ii) Knowledge Acquisition
- (iii) Knowledge Representation
- (iv) Design of the Prototype
- (v) Implementation
- (vi) Testing of the Knowledge Base
- (vii) Evaluation.

This development process deviates slightly from the 'Traditional Approach' and uses the 'Radical Approach' to the system development life cycle.

The first stage involves initial analysis of the problem, discussions with instructional designers, authoring language programmers and analysts as well as content experts. An attempt was made to define the requirements of the system from the user perspective. An ongoing literature search has also been underway since the beginning of this project.

The knowledge acquisition stage involves the gathering of knowledge on instructional design and computer Assisted Learning development from books, articles, the personal knowledge and experience of instructional designers as well as authors of CAL courseware.

Knowledge on instructional design includes the recommendations and guide-lines from instructional design theory, and it is kept very practical as it is not aimed at producing instructional design experts, but rather to give sufficient practical hints and knowledge as to improving the quality of courseware.

A systematic design of training has been adopted and includes knowledge on needs analysis, task analysis, entry behaviour analysis etc.

It will also include knowledge on the design of aims and objectives, criterion referenced tests, content mapping and content synthesis, as well as teaching/learning strategies and assessement/evaluation methods.

The CAL development knowledge base will include procedures for courseware development, computer graphics design, screen design and other 'user interface' design principles.

The Knowledge Representation stage will involve the use of Knowledge Representation techniques developed in work with Artificial Intelligence.

Some of these Knowledge Representation techniques will include:

- (i) Procedural representation for knowledge involving procedures such as content based test specifications, the writing of specific objectives, or analysis of goals;
- (ii) Semantic Networks representing concepts or situations in the knowledge domain. For example, some cases of content mapping;

(iii) Production Rules to handle If...Then... knowledge; and

(v) Frames, which will be used to organise and classify the knowledge of the domain.

Frames are particularly useful as they can be used with other forms of knowledge representations and hence they will enable the entire knowledge domain to be 'brought together'.

4 Current State of the Project

The project is currently in the Knowledge Acquisition stage, although representation of some knowledge has already begun.

The knowledge Base is being constructed using Turbo Prolog, a tool which makes possible many forms of Knowledge Representation and can be used to produce very powerful inferencing systems.

5 Conclusion

This is a preliminary presentation of the development of an Instructional Development Expert Advisory System which is designed to assist content experts in preparing CAL courseware prototypes. It will act as a guide and adviser to the user, who will be able to consult the system to request information, advice, hints, and procedures about the development process of CAL courseware.

Although the project is still in an embryonic stage and its feasibility cannot be tested, it is hoped it will prove to be a useful tool for users of CAL authoring packages as well as designers of print based courseware.

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THE INFORMATION SYSTEMS STREAM AT DEAKIN UNIVERSITY

by

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ABSTRACT

This paper presents the current Information Systems program at Deakin University.

This program has provided students with a clear understanding of Information Systems concepts equipping them for positions as Information System Architects and Technicians. A feature of the program is that it also interfaces with Computer Science.

In addition, the stream can be taken by students from the School of Management where the Information System managers will emerge.

In this paper we categorise the personnel involved in developing Information Systems and their functions as:

1. Architects - planning and design
2. Technicians - implementation
3. Managers - planning and management

1. Introduction

Traditionally, universities have been giving courses in Information System (IS) disciplines to teach students the skills necessary for developing systems in a data processing environment. As information technology has significantly developed in recent years, the environment has changed dramatically. For example, centralised database systems have become distributed because of a change in computer system architecture; from uniprocessor systems to computer networks. In addition, the current Program Support Environments (PSEs) with a background in Artificial Intelligence (AI) provide sufficient support for developing expert information systems covering relevant applications. A new and sophisticated IS environment requires the help of intermediate professionals, whom we shall term IS architects to interface with IS planners (or managers) and with the IS implementors (i.e. programmers). This dictates that academic departments should evolve courses which introduce skills not only for the normal data processing environment, and also for the new IS environment. The knowledge required by IS architects can be specified as follows:

- computer system architecture;
- software and programming support tools (e.g. CASE tools);
- system analysis;
- information engineering;
- database techniques;
- commercial and logical programming;
- project management;
- design of expert systems. (See Figure 1).

On the other hand, IS programmers need to specialise in programming techniques which include commercial 3GL's, relational database programming techniques, logical programming (e.g. LISP and PROLOG) and other application tools (e.g. spread sheets, word processing, graphics packages, etc). Hence, the framework for an IS stream should emphasise:

1. the skills required by an IS architect and
2. the training in 3GL's and other more modern tools required by an IS technician (or programmer).

This paper will now describe the different course disciplines offered in the Department of Computing and Mathematics at Deakin University, briefly discuss the course structure for Information Systems and the linkage between it and Computer Science and then, outline the details of units available in Information System stream. We conclude with a description of predicted changes in the environment and their effects on course development in the longer term.

2. Course Disciplines

The department offers courses that overlap between two or more specialisations. The available specialisations are Computer Science, Information Systems, Mathematics, Electronics and Management.

A complete degree comprises 24 units in total and can be completed in three years. Generally, a successful student from our department graduates as a Bachelor of Science after specialising in one of the following disciplines:

- Information Systems / Computer Science
- Information Systems / Management (double degree in Science and Commerce)
- Computer Science / Mathematics
- Computer Science / Electronics
- Computer Science / Mathematics / Electronics

Although many different options are available as shown above, the majority of students choose the first option because most feel an IS specialisation will give them a balanced perspective. Therefore the most choose their courses expecting that they will eventually obtain employment in this area.

(1 Unit corresponds to 1.5 hours/week through a semester)

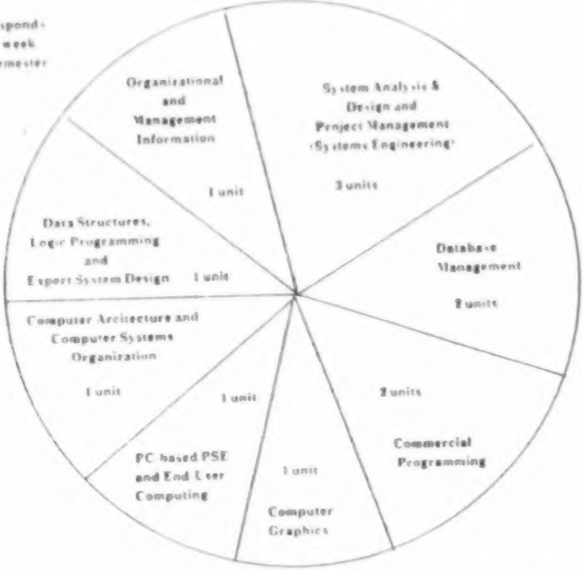

Figure 1 Knowledge Required by an Information Architect

3. The Current Information Systems Course Structure

The new environment created by current information technology requires that more emphasis be placed on:

- the use of PC-oriented PSE;
- designing distributed systems and
- designing systems of a dynamic nature using AI-techniques.

At the same time, the data processing environment developed in the past and not yet replaced still requires that the IS professional be conversant with traditional 3GL's such as COBOL, Pascal and C. Considering all of these factors, our stream has a PSE which is a Unix based file server which supports 3GL's, DBMS's and PC software. This enables the study of a commercial programming language, file structures, commercial database design, system analysis and design, systems engineering, data communications and networks and expert system design.

A framework of courses required for the degree with specialisation on Information Systems and Computer Science is shown in Figure 2.

We shall now discuss the options available in the Computer Science stream and then provide a rationale for an interface between this stream and an Information Systems major. We will then discuss the components of the Information Systems stream.

3.1 Computer Science stream

In all degree options, the Introduction to Programming (SCP115), Data Structures (SCP125), Computer Architecture (SCP215), Operating Systems Principles (SCP225) and Comparative languages (SCP317) and Real-Time Systems (SCP315) are core units from the Computer Science stream. The course on Comparative Languages introduces some language tools that are necessary for logic and object-oriented programming. At present Real-Time Systems (SCP315) deals with the basic concepts such as concurrent programming techniques and real-time operating systems. Our future plan is to enhance the contents of real-time systems by introducing an additional course. This new course will be using CASE tools to design and evaluate practical real-time systems. In fact, most of our Computer Science courses have had a design emphasis rather than a theoretical one purposefully in order to support the Information Systems stream. As they represent courses in Computer Engineering [Denn,89], they can therefore be considered as foundation courses for IS specialists.

3.2 Information Systems stream

This stream commences with a course in Statistics using a PC environment (SMC111) introduces students to the MS-DOS operating system and some commercial tools that include spreadsheets, database packages and statistical packages. A alternative unit offered for the management students (SCM141) deals with computer systems and business information systems. This course introduces the knowledge required for the emerging PC-technology.

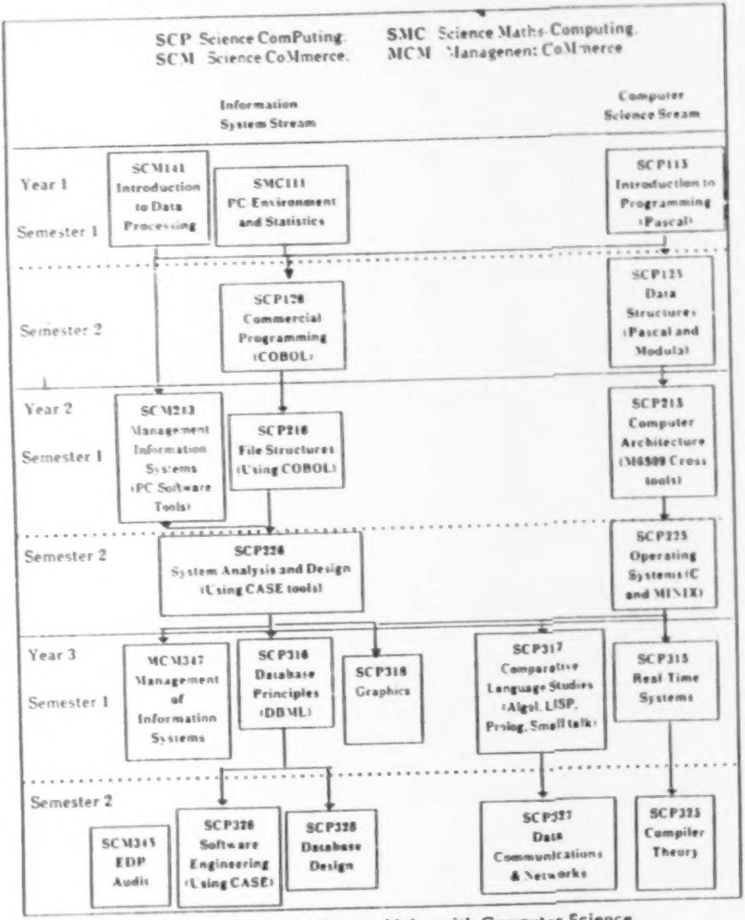
SCP Science ComPuting.
SCM Science CoMmerce.
SMC Science Maths Computing.
MCM Managenent CoMmerce
Information System Stream
Computer Science Sream
Year 1
Semester 1
SCM141 Introduction to Data Processing
SMC111 PC Environment and Statistics
SCP113 Introduction to Programming (Pascal)
Semester 2
SCP120 Commercial Programming (COBOL)
SCP125 Data Structures (Pascal and Modula)
Year 2
Semester 1
SCM213 Management Information Systems (PC Software Tools)
SCP210 File Structures (Using COBOL)
SCP215 Computer Architecture (M6809 Cross tools)
Semester 2
SCP220 System Analysis and Design (Using CASE tools)
SCP225 Operating Systems (C and MINIX)
Year 3
Semester 1
MCM347 Management of Information Systems
SCP310 Database Principles (DBML)
SCP318 Graphics
SCP317 Comparative Language Studies (Algol, LISP, Prolog, Small talk)
SCP315 Real Time Systems
Semester 2
SCM345 EDP Audit
SCP320 Software Engineering (Using CASE)
SCP328 Database Design
SCP327 Data Communications & Networks
SCP325 Compiler Theory

Figure 2 Information System Major with Computer Science

Management students have an option to cease computer studies having completed this unit.

If they continue, they complete an introductory course in COBOL and structured programming techniques including report generation and sequential file applications. In the first semester of second year, they complete a course in file structures (SCP216) including ISAM, VSAM, etc.

Students are able to complete the commercial programming units and Introduction to Management Information systems (SCM243) before moving into the Systems Analysis unit (SCP226).

The Introduction to Management Information Systems course will introduce students to the concept of MIS (organisational structure, types of information at managerial level, abstraction principles in dealing with management information, etc) and end user computing (i.e. training on tools that are similar to fourth generation languages). The students will also study the type of problems which various levels of management are faced with and then become familiar with some of the tools which would be used to solve these problems. We will be using PC-software tools such as RBase for DOS which is a relational DBMS providing the user with an advanced interface to problem solving. The user interacts with the software by defining the database structure, specifying the nature of the application, designing data entry screens and report formats. The application is generated by the software producing command files which can also be modified using an editor. This software will allow the students to develop solutions quicker than the COBOL equivalent. They will be able to solve a wider range of problems and develop problem solving techniques which can be applied to most situations. This solution is achieved quickly if appropriate planning occurs at the initial stages. Students do not have to grapple with the syntax of a 3GL and lose sight of the problem. Instead they are developing important strategies for problem solving because the environment is so advanced. Developing an understanding of the environment in which these solutions will be implemented is also an important component of this course.

We feel that future IS courses should focus more on an understanding of the organisational problems and developing skills for solving problems using a PC-based PSE.

It is intended to introduce CASE tool software into the Systems Analysis course (SCP226) for the same reasons. In the long term we think we should introduce this environment to first year students and then provide shorter, and detailed courses in traditional languages later in their studies.

The Systems Analysis (SCP226) unit is seen to be one of the core units of the Deakin course. It is at this juncture that 'open campus' teaching is introduced. This means that formal lectures are not conducted because that pedagogical technique is seen to favour the fastest writer or those who have expertise in shorthand. A comprehensive Study Guide is provided, on paper, together with a Reader to supplement a well written textbook. At the moment we are using Systems Analysis and Design by Ken and Julie Kendall

(Prentice Hall, 1988). This unit is paper based. It does not use any electronic mail and requires no programming. A compulsory tutorial is to be attended once per week. Each tutorial can be prepared in about one hour by the student and aims to cover one specific point. All tutorials are 'theoretical'. Since all of the material is released at the beginning of the course, the progress through the course is predictable from the students' point of view. We expect, however, that the use of CASE technology and the necessity of providing tutorials for its use will mean a substantial rethink regarding aims and objectives. The CASE tools we will be using are Easy Case at first year level and Excelerator and Software Through Pictures at second and third year level.

In the first semester of third year they are introduced to database concepts (SCP316) including commercial database design, database modelling and relational databases. In this unit they also use a CODASYL database which interfaces to COBOL. Although we recognise that CODASYL databases are almost obsolete, an understanding of linking and maneuvering with this type of database provides an excellent basis for understanding the less complex database structures in current use. Similarly, we have found that by completing an extensive assignment work in one language (in this case COBOL) students acquire the skills which are necessary for program development in any language.

We also introduce Software Engineering (SE) (SCP326) and Database Modelling (SCP328).

We currently provide one undergraduate unit in SE. This unit follows directly from the Systems Analysis and Design unit described above. However, the predictability of the SCP226 unit is now replaced with an element of personal decision making. The students are grouped into teams of four each team having the responsibility of developing a software product using document pro-formas over a period of 12 weeks. Each team develops a product which is assessed upon the following criteria:

.Did the documentation follow the pro forma?
.Did the product work?
.Was it delivered on time?
.Was there an external user?
.Was it simple or complex?
.Was it a professional software product?

Each team competes against other teams. Those who interfaced with an external user get more marks than those who did not. Those who implemented a complex system get more marks than those who implemented a simple system.

In 1989 a team developed a student housing system for Deakin which was then adopted by the University. Other projects were also adopted by external users.

In 1990, 5 out of 11 teams implemented systems which were placed into production by external users. The Geelong Hospital is using two of these systems. One is a payment system for visiting medical officers and the other is a drug enquiry system.

The theory of software engineering is taught, once again, using the open campus mode i.e Study Guide, Reader and well written textbook. Teams are expected to use CASE technology for analysis and design and then develop the system using a relational database or a programming language. We are currently planning an additional unit to be held in the 4th year (i.e. Honours) to provide an in depth study of real time and object oriented SE. The technical approach that we will adopt in this unit is we believe is another link between Information Systems and Computer Science.

This style of Information Systems course will initially provide the architectural skills and then develop the technical skills later.

Informal surveys have indicated that graduates from our courses appear to have a good track record with employers because many of them are skilled in the systems and techniques which are currently being used in industry. This will hopefully make them more effective employees and reduce the amount of initial in-house training required.

4. The Impact of Secondary School Computing Courses

The introduction of Information Technology (IT) at the VCE level in Victoria will have an effect on the structure of undergraduate courses in the 1990's (in particular 1st year courses) which we will need to take into account in future course design.

Students will be entering university with (in some cases) substantial skills in programming languages, application software and knowledge of information systems. It would be a pity if we didn't take advantage of this and provide extension or alternative courses for students in their first year. Students who have achieved satisfactory grades in Information Systems or Information Processing and Management may gain entry to an advanced stream.

The advanced stream could concentrate on more detailed and extensive treatment of the subject. It may also provide the opportunity for students to be involved in group work or small projects. Courses which concentrate on the use of application software will not be suitable for students who have studied Information Technology (IT) units 3 and 4 at the secondary level. First year tertiary courses will have to cater for a more experienced clientele.

5. Double B.Sc. and B.Com Degree

By completing sixteen units from the School of Sciences and sixteen units from the School of Management over a four year period, students are able to fulfil the requirements to Bachelors degree in both Science and Commerce. Entry requirements for the Australian Society of the Accountants and the Australian Computer Society also can be satisfied with this program. Almost all students completing a combined degree choose the Information Systems streams for their course. Opportunities exist for a double degree in Management and Science which would take four years to complete but at this point of time, this option is not generally taken up even though these graduates are sought after by employers. The reason that this option is currently not usual is because of the state of the labour market: why should an individual forego a year's income when jobs are readily available. However a change in the state of affairs may mean the double degree option may be considered attractive by more students.

6. The Future

Our department is currently reviewing the present framework of IS in the light of a merger with Warrnambool Institute of Advanced Education. At this stage three areas of Information Systems have been identified:

1. Information Engineering
2. Programming
3. Management

The Information Engineering area which includes software engineering and system engineering may have a profound effect on all areas of Information Systems and Computer Science courses. Introduction to AI and Expert Systems will also occur in the Information Engineering stream. Many institutions are currently making changes to traditional approaches followed in their IS streams. We will also be developing courses in Information Engineering at the postgraduate level which will be supported by a Software Engineering laboratory.

7. Conclusion

Our Information System course at the undergraduate level is being tuned to suit the current demand of the computer industry.

Most of our effort at undergraduate level has been spent to produce good IS architects. We realise that attention to theoretical Computer Science is a necessary adjunct to IS technology and have attempted to provide an exposure to it via the design of the courses.

As a final note students who are keen to pursue research proceed to the honours program where most of the effort thus far has been in the Information Systems area.

8. Acknowledgments

The current course has developed through the efforts of many staff at Deakin. Any opinions expressed in the paper are those of the authors.

The paper has been reviewed and approved by the Head of the

Computing/Maths department, Dr. Ian Collings and the Head of the Information Systems section, Professor Brian Garner.

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TEACHING INFORMATION SYSTEMS I VIA PERSONALISED SYSTEM OF INSTRUCTION; TAKING RESPONSIBILITY FOR YOUR OWN LEARNING

by

Elaine Lawrence

ABSTRACT

The growth of technology has led to a significant increase in the number of university students undertaking the study of Information Systems. At the same time the universities need to reduce the teaching load of lecturers but maintain the depth of content of courses

The University of Western Sydney, Nepean has streamlined the procedure of teaching Informations Systems I via the use of the Personalised System of Instruction. This paper reports on the successful implementation of this mode of delivery for such a course.

The course attracts over 700 students per year and has been developed as a self paced, self study unit combined with practical, computer based, problem solving assignments.

PSI emphasises the following properties in its operation:

1. accent on the written word via a text book, study guide and mastery tests
2. stress on the mastery ideology of learning that allows the learner to progress to the next unit of material after successfully displaying complete understanding of the existing material
3. self pacing
4. use of conventional lecture time for learner motivation instead of simply learner information
5. use of students to help train other students in a 'peer proctor' relationship.[1]

The author, the co-ordinator of Information Systems I at UWS, Nepean during 1990 will outline the successful implementation techniques. She will also present results of a survey of 2nd semester students.

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[1] Robert S Ruskin, *The Personalised System of Instruction: An Educational Alternative*, ERIC/Higher Education Research Report No 5, 1974, Washington DC

TEACHING INFORMATION SYSTEMS I VIA PERSONALISED SYSTEM OF INSTRUCTION; TAKING RESPONSIBILITY FOR YOUR OWN LEARNING

by

Elaine Lawrence

University of Technology Sydney
Kuring-Gai Campus

INTRODUCTION:

The growth of technology has led to a significant increase in the number of university students undertaking the study of Information Systems. At the same time the universities need to reduce the teaching load of lecturers but maintain the depth of content of courses.

The University of Western Sydney, Nepean has streamlined the teaching of Information Systems I with the use of the Personalised System of Instruction. This instructional technique, also known as the 'Keller Plan' but from now on referred to as PSI, was developed by Fred S Keller and J Gilmore Sherman in the 1960s at Columbia University and the University Of Brazilia. Broadly it emphasises dividing and sequencing material into small sections for more efficient learning, the use of study guides to help learning, the provision of immediate feedback, self pacing and mastery of information.[1] It is important to realise that PSI is always in a state of adaptation and this paper outlines the experiences of the writer as co-ordinator of Information Systems I at UWS, Nepean in 1990.

First this paper will examine why Information Systems is studied, the client group and the Mode of Delivery of the course.

Second the five principles of PSI, as put forward by Keller and Sherman, will be surveyed.

Third the practical application of PSI at the University of Western Sydney, Nepean will be outlined. Both the successful strategies and the problem areas will be dealt with.

Finally the writer will present a graph of results achieved by second semester students and comment on the effectiveness and efficiency of PSI.

WHY STUDY INFORMATION SYSTEMS

Computer based systems are a dominant force in our society and are becoming a necessary part of our lives. Airlines, travel agencies and hotels make use of extensive networks of computers. Businesses use computers for sharing data, preparing documents, sending messages and performing clerical duties. The University of Western Sydney, Nepean believes it is important for all students to gain a basic knowledge and understanding of computers, of how this powerful tool affects our lives and how we can make it best serve our needs.[2]

Most departments at UWS, Nepean have an expectation that their students will be able to successfully use a word processor, a spreadsheet and a database on a computer by the time they have completed Information Systems I. Indeed some of the learning outcomes of the course are forced on the co-ordinator lecturer. For example, the Department of Accounting expects that their students will have a basic understanding of spreadsheets by the time they finish Information Systems I. As a result a spreadsheet assignment was made a compulsory item for a passing grade.

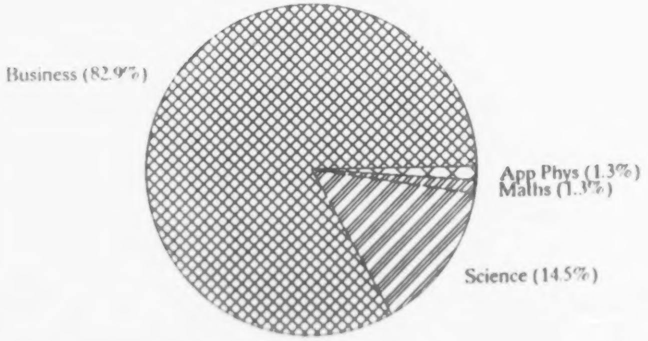
THE CLIENT GROUP

Students from the Schools of Business and Science and Technology are obliged to undertake Information Systems I as part of their degrees. The course is offered at both the Kingswood and Westmead Campuses. In Semester 1, 1990 over 500 students were enrolled in the course whilst in Semester 2, a total of 252 were enrolled.

The writer of this paper conducted a survey of 62 students at Kingswood and of 92 students at Westmead in October 1990. The graph (Figure 1) below represents the different types of degrees the second semester survey students were undertaking.

Figure 1

Second Semester 1990 Survey – –Kingswood & Westmead Respondents
Different Types of Degrees



MODE OF DELIVERY OF INFORMATION SYSTEMS I

This course has been developed as a self paced, self study unit based on the principles of the Personalised System of Instruction. This self paced strategy has been combined with some practical, problem solving tasks. It is considered important for students to acquire sound technical and application skills and it is believed that the assignments address these matters.

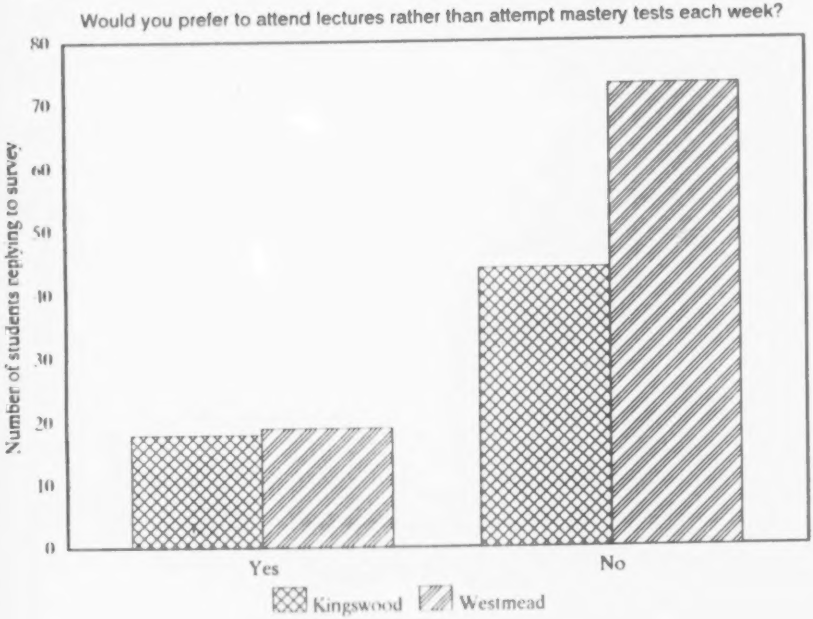
It should be pointed out that the application of the PSI methodology has been modified to suit conditions at UWS, Nepean. The course has been offered since 1983 and this paper outlines the writer's experiences and adaptations in 1990.

The lecture mode of delivery has been dropped from this subject. The main purpose of the unit is the transfer of information and the PSI method has been selected as the most appropriate. Some of the students come to this course with a vast amount of computing knowledge and say, no business or science knowledge whilst others have a business or a science background but no computing knowledge. Lecturing to such a disparate group means it is very difficult to get the content and pace right.

PSI allows students to go at their own pace. The students are expected to study a module of work (two chapters of their text book at a time) and present themselves at the University when ready to complete a mastery test. If they pass they are able to move onto the next module. The students are also expected to complete practical computer based assignments. In order to obtain a Pass in the course students must successfully complete at least nine modules. The implementation of the course will be described in greater detail later in the paper.

PSI has proven to be highly satisfactory to the student body according to the results of my survey. The graph (Figure 2) below illustrates that the majority of students at both campuses preferred the mastery test method to a lecture method.

Figure 2



THE FIVE POINTS ABOUT PSI

In general, the Personalised System of Instruction emphasises five principles:

a) A stress upon the written word
b) A mastery philosophy
c) A self paced ideology
d) Lecture time replaced by study and motivation time
e) The use of proctors [3]

Below the writer outlines the manner in which UWS, Nepean has developed its model according to these principles.

a) A Stress upon the Written Word:

The students are required to buy a text book, in this case, Computers and Information Processing. The Complete Course, by Steven Mandell, plus the study guide and a DOS Primer written by Bernd Jansons, a lecturer from UWS. The text book has been chosen for its coverage of course content, its understandable prose, its photographic and diagrammatic displays, its educational-version disks of popular software, its tutorial supplements on software and Basic programming and its accompanying study guide.

The students are given an introductory lecture on the requirements of the course and handed the following documents:

Course outline and requirements
Assignments 1(a), 1(b), 1(c)
Assignments 10(a), 11(a)

These documents are colour coded for ease of identification.

In order to understand how PSI is implemented we need to study Figure 3, 'Unit Content and Assessment' which outlines the course. This document forms part of the Course Outline which is handed to each student.

As can be seen, the course is split into 3 sections. There is a core content section which must be completed by all students if they are to obtain a Passing grade and there are two supplementary content sections. If students pass the core content and Modules 10 and 10(a)(the Credit Grade content) they are able to achieve a Credit. If students elect to do the Core content, the Credit Grade content and Modules 11, 11(a) (the Distinction Grade content) they are able to achieve a Distinction.

In a further adaptation of the PSI paradigm, UWS, Nepean awards a High Distinction to all those students who pass all the mastery test modules on the first attempt.

Figure 3

UNIT CONTENT AND ASSESSMENT

CORE CONTENT (PASS GRADE)

Assessment By Practical Assignment

Module 1(a) Assignment	Using a Personal Computer
Module 1(b) Assignment	Wordprocessing
Module 1(c) Assignment	Spreadsheet

Assessment by Mastery Examination

Module 2	Introduction to Computing
Module 3	Information Systems
Module 4	Computer Hardware and Input/Output
Module 5	Storage Devices and File Organization
Module 6	Application Software and S A & D
Module 7	MIS, DSS and Computer Security & the Law
Module 8	Social & Management Issues
Module 9	REVISION TEST

SUPPLEMENTARY CONTENT (CREDIT GRADE)

Assessment by Mastery Examination

Module 10	Telecommunications & Systems Software

Assessment By Practical Assignment

Module 10(a) Assignment	Database

SUPPLEMENTARY CONTENT (DISTINCTION GRADE)

Assessment by Mastery Examination

Module 11	Software Development & Programming Languages

Assessment By Practical Assignment

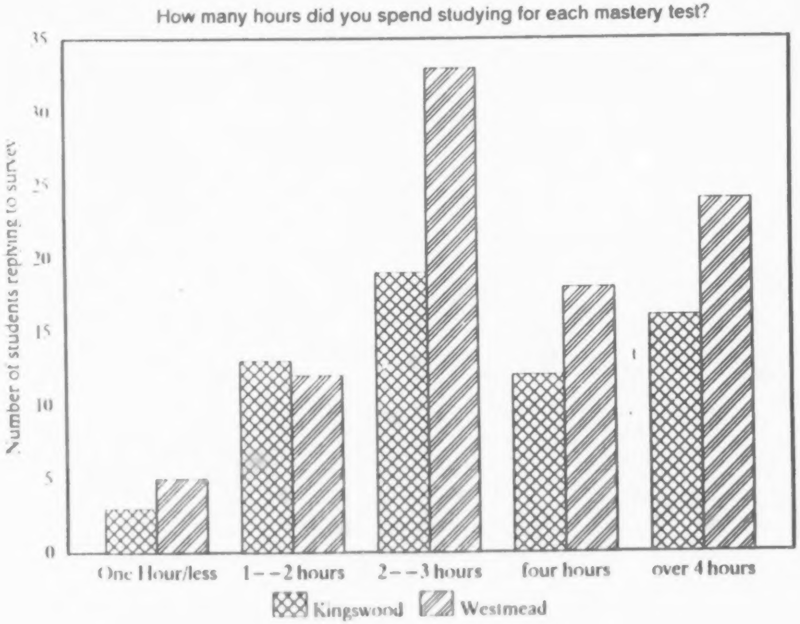
Module 11(a)Assignment	BASIC programming

NB: A HIGH DISTINCTION IS EARNED BY PASSING ALL MASTERY TEST MODULES ON THE FIRST ATTEMPT

b) A Mastery Philosophy:

The students are directed during the introductory lecture to the above outline and guided through the ideas. Firstly it is pointed out that the students are in control. They must decide themselves how much time they need to spend in 'class' and how much time they need to devote to a module or unit of work. Figure 4 is a graph that shows how much time the surveyed students estimated they spent studying each week.

Figure 4



The students may devote that time at either a formal session at the university or at home. Once the students believe they understand the content of the module being studied they may attend a session at University and attempt a mastery test. Tests are taken as many times as necessary on a given module until a threshold level of mastery is reached. The passing grade is 90% and it has been chosen to ensure the students have a sufficient depth and breadth of understanding of the module. As a module represents a small amount of material (two chapters) and the test is carried out close to the learning time, it is not considered unreasonable to expect students to achieve this percentage. As this is a university level course it is important that the questions are not light and trivial. The tests must aim to ensure that the students have achieved this depth and breadth of understanding. Many students who were surveyed commented on the fact that the mastery philosophy enabled them to learn throughout the semester rather than trying to cram all their learning into a 3 week session before a final exam.

The mastery philosophy is based on the idea that if 'one is interested in undergoing successful surgery or getting his automobile repaired, then the important consideration in viewing the surgeon or automobile mechanic is whether they have "mastered" the skills involved, and not how long it took to gain the medical degree or the mechanics certification'[4]

c) A Self Pacing Ideology:

The students are able to proceed through the modules as quickly as they can. They are not able to move up to the next module until they have passed the module they are working on. Thus some students may elect to work quickly and simply go for a pass. Indeed several students at Westmead finished the core content by week 10 and left the course, knowing that they had achieved a passing grade of 9 modules, to concentrate on their other subjects. Others, upon realising that they had achieved a Passing grade early in the semester, were spurred on and carried on to obtain Distinctions.

d) Lecture Time replaced by Study & Motivation Time:

The lecturer uses study material, self paced testing and mastery to present the essential material. The lecturer is available during the scheduled class time for consultation. Students who are having trouble with the material may approach the lecturer for clarification. Proctors are also available for consultation both in the study/mastery session and in the computer rooms. The lack of formality is conducive to a more pleasant lecturer/student relationship.

e) Proctors:

Proctors are advanced undergraduate students who are in their second or third years. They are the worker bees of Information Systems I at UWS, Nepean and perform many functions such as registering students, handing out tests, supervising tests, marking tests and helping the students who are experiencing difficulties with the course or the assignments. Being students themselves, they are sympathetic to the Information Systems I students and they are chosen for their ability to communicate effectively, their understanding of the course content, their willingness to help and their maturity.[5] Indeed the proctors have been through the Information Systems I course themselves and most have been High Distinction or Distinction students.

PRACTICAL APPLICATION OF PSI AT UWS, NEPEAN

In order to appreciate how UWS, Nepean has adapted the PSI methodology it is worthwhile to look in detail at some of the practical measures that were undertaken in the running of Information Systems I, in 1990.

Housekeeping Matters:

In 1990 the course was offered for six hours per week at both the Kingswood and Westmead campuses in Semester 1 and for three hours per week at Kingswood and six hours per week at Westmead in Semester 2. In both instances a double room with a sliding door was allocated for the subject. One room was termed the mastery test room and the other the study room, as it was found beneficial to keep the students who were being tested in a quiet area where there was little movement and background chatter. It was also easier to supervise the testing in a separate room. In the mastery test room the mastery tests, student documentation, answer sheets and administration details were kept in two locked four drawer filing cabinets. Students entering the mastery exam room to sit for a paper only bring in a pencil, a rubber and their student identification card. They approach a proctor whose duty it is to find the 'Student Progress Sheet' (Figure 5), update it with a tick indicating which test is to be attempted, attach the student's id card to it and issue the student with a mastery test consisting of 20 multiple choice questions and an answer sheet. The student progress sheets were kept in an expanding alphabetical file.

When the students have finished their papers they place both the mastery test and answer sheet in a wire basket and return to the study room to wait for a proctor to call them once the paper is marked. More information about the proctors' duties will be discussed later in the paper. If students have been successful their Progress Sheets are marked as a pass, dated and initialled by the proctor and they may leave.

The student is therefore able to decide whether

a) to go back to the study room and perhaps try to pass another module later on in the session

or

b) to go to a Personal Computer laboratory and work on an assignment

or

c) to go home

Figure 5

18515 -- INFORMATION SYSTEMS 1 STUDENT PROGRESS SHEET

STUDENT NAME ____________________ STUDENT NUMBER ____________________

CORE CONTENT (PASS GRADE) **Assessment by Practical Assignment**

Assign No	Topic	Date Due	Resub	Init	Date passed	Init
1(a)	Using a P C	AUGUST 24 1990				
1(b)	Word Processing	SEPT 7 1990				
1(c)	Spreadsheet	SEPT 21 1990				

CORE CONTENT (PASS GRADE)--Assessment by Mastery Examination

Module No	Topic	Exams				Date passed	Init
		A	B	C	D		
2	Intro to Computing						
3	Information Systems						
4	Hardware & I/O						
5	Storage & File Org						
6	Software & SAD						
7	MIS, DSS, Security						
8	Social/Manage Issues						
9	Revision Test						

****

SUPPLEMENTARY CONTENT (CREDIT GRADE)--Assessment by Mastery Examination

Module No	Topic	Exams				Date passed	Init
		A	B	C	D		
10	Telecom & Sys Soft						

Assessment by Practical Assignment

Assign No	Topic	Date Due	Resub	Init	Date pass	Init
10(a)	Database	OCT 19 1990				

****

SUPPLEMENTARY CONTENT (DISTINCTION GRADE)--Assessment by Mastery Exam

Module No	Topic	Exams				Date passed	Init
		A	B	C	D		
11	S/ware & Program.						

Assessment by Practical Assignment

Assign No	Topic	Date Due	Resub	Init	Date pass	Init
11(a)	BASIC Prog	NOV 2 1990				

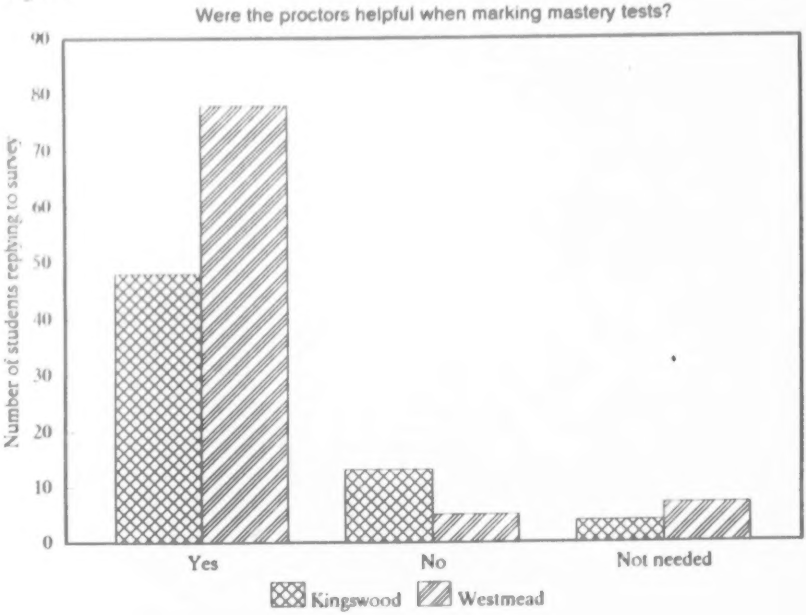
The Use of Proctors:

In 1990, UWS, Nepean used approximately one proctor per 25 students. It has been found that once the student body passes 220 students, our so-called critical mass, the work load per proctor was too high and the waiting time for students to be tested or graded became unacceptable. It has therefore been decided that if the student numbers pass critical mass there should be one proctor per 20 students. The writer found it more successful to allocate specific duties to specific proctors so, for example, one proctor per session was given the duty of allocating mastery tests to the students, three proctors were given the task of marking the mastery tests, one student was allocated to the PC rooms to assist with practical assignments and, at slack times, one or two proctors would assist with the marking of assignments.

The mastery tests normally consist of 20 multiple choice questions and the students are allowed 30 minutes to complete the test. The proctor who marks the test discusses any incorrect answers with the students. If a dispute develops the lecturer is called and is the final arbitrator for test grading or course content.

Proctors are employed as casuals for 3 hours per week for 13 weeks. In 1990 they were paid $10 per hour. There are peaks and troughs in student attendance. Many students would arrive at starting time or at six pm when part timers arrive at university. Enough proctors should be on duty at these busy times. Figure 6 is a graph showing that the majority of students believed that proctors were helpful in the marking of the mastery tests.

Figure 6



The Use of Lecturers:

At UWS, Nepean the course co-ordinator lecturer is classified as full time as that lecturer is responsible for preparing the multi choice questions, the assignments, the hiring of proctors, keeping of marks and administration. Supporting lecturers are granted 2 hours duty time for each three hours served. They do not have any start up preparation or final examination marking but are expected to have a good all round knowledge of the whole course. As a general rule one lecturer with three proctors is allocated to each 80--100 students.

During the sessions the writer found it useful to concern herself with the administration details, marking of assignments and supervision of tests in the mastery test room. The supporting lecturer sat in the study room and was able to assist any student with queries, or give mini tutorials to groups of students having difficulties with specific concepts. Because of the self paced nature of the course lecturers may be asked questions across a whole spectrum of information.

The Mastery Tests:

As can been seen from Figure 3, 'Unit Content and Assessment', there are 11 modules for the entire course. Module I consists of the practical assignments and will be discussed later. Modules 2 - 8, 10 and 11 each contain 20 multiple choice questions and each of these modules cover two chapters from the chosen text book. There are 4 versions of each module, that is 2A, 2B, 2C, 2D, 3A etc. Students are expected to gain 90% or higher if they are to attain a passing grade. The writer found it useful to allow students with a score of 16 or 17 to be allowed to try to upgrade their pass to a 18 with the proctor. If the student's results are unsatisfactory, the proctor runs through the test with the student and advises the student to go away to study a little longer before coming back to attempt a different version of the test. Any student who has failed 3 versions is automatically sent to a lecturer for counselling and assistance. The idea of the course is to help the student master the content. The writer noticed that some students who had English as a second language found it useful to discuss a module's content with a lecturer or a proctor.

Module 9--A Review Mastery Test:

In another diversion from a pure implementation of PSI, UWS, Nepean has made Module 9 a full revision module. This module consists of 38 multiple choice questions covering the full range of material contained in Modules 2--8. There is also a short essay type questions which requires an answer in no more that 20 lines. There is a choice between 2 topics for this question. The student is allowed 60 minutes to complete Module 9.

The purpose of the review module is to test the students' long term memory and it takes the place of a final examination.

Keeping up with Mastery Tests:

The students are advised to try to complete at least one module per week but in each semester in 1990 the writer was surprised by a least one student who came late and managed to pass the course. One such student commenced his mastery tests at Westmead Campus in Week 12 and finished his tests by Week 15. He left the course with a Pass to concentrate on his other subjects. He stated he found the system very effective as he was a part time student who often had to go on business trips.

Mastery Test Questions:

The co-ordinating lecturer needs to have a clear understanding of what needs to tested before setting the mastery tests. It was useful to go through the test bank and eliminate any irrelevant questions and then select the questions from those remaining. Despite this, it was noted that some of the questions caused problems during the first semester, for example, students had difficulty interpreting them or they were too detailed. It is valuable for the co-ordinator to make a note of troublesome or irrelevant questions and revise the tests before the next semester. It is also stressed that it is useful to change tests in case some answers start to spread around the campus. In other words, the writer does not believe that it is enough to simply prepare your tests and keep them for the next 5 years. Further the writer believes that one only gets a true idea of the effectiveness of the tests after the students have 'tested' them.

Text books which come with test generators are a great assistance in preparing mastery tests but again, the lecturer must still cull out irrelevant, trivial or difficult to interpret questions.

The co-ordinating lecturer should always review new texts to make sure that the course is kept up to date. The writer has decided to keep Mandell's book for 1991 but she has revised the mastery tests in the light of her experiences in 1990. Of the students who were surveyed 44% found the text book and study guide easy to study, 7% found them hard to study whilst 49% found them suitable.

Mastery Test Attempts:

The writer's research shows that in second semester 1990 students took 2 tries on average to pass a module.

Assignments:

As can be noted from Figure 3, 'Unit Content and Assessment', in order to obtain a Passing grade, students need to pass three assignments ie Module I. In 1990 the students were expected to learn about MS-DOS for the first assignment, a word processor for the second assignment and a spreadsheet for the third assignment.

The University of Western Sydney, Nepean expects that student will have practical computing skills as a result of passing Information Systems. It is not considered sufficient to merely know the theory of computing. Practical hands-on assignments required students to complete such tasks as formatting disks, copying files, creating subdirectories, preparing letters, printing documents, creating and printing spreadsheets for a passing grade. Those students who wished to obtain a Credit had to manipulate data in a Database management package whilst those who wished to try for a distinction had to write a BASIC program. In the assignments an emphasis was put on practical useful tasks which would encourage students to further develop their interest in computing.

Students could obtain help with their assignments from proctors, lecturers, other students and their text book which contained tutorial-like supplements on Word Perfect, VP Planner Plus, DBase III Plus and BASIC. The students had A DOS Primer by Bernd Jansons for assistance with their first assignment.

Due dates:

In a change of pace from previous years, the writer set due dates for the assignments and specified that there would be no leniency shown for late assignments unless accompanied by, say, a doctor's certificate. In previous years a due date was not an option and students were able to present their assignments when they were ready. Discussions with proctors and previous lecturers confirmed that this methodology had caused some administrative problems in the previous years. The due date system introduced in 1990 found favour with supporting lecturers and proctors who felt it enabled the marking and recording of assignments to be accomplished in a more businesslike and efficient manner.

The writer attempted to mark assignments during the sessions with the help of a couple of proctors. The writer ensured that proctors were issued with model answers to assist them in their marking tasks. It was also necessary for proctors to discuss any problem assignment with the co-ordinating lecturer. The writer tried to ensure that assignments were turned around in two weeks.

Grading of Assignments

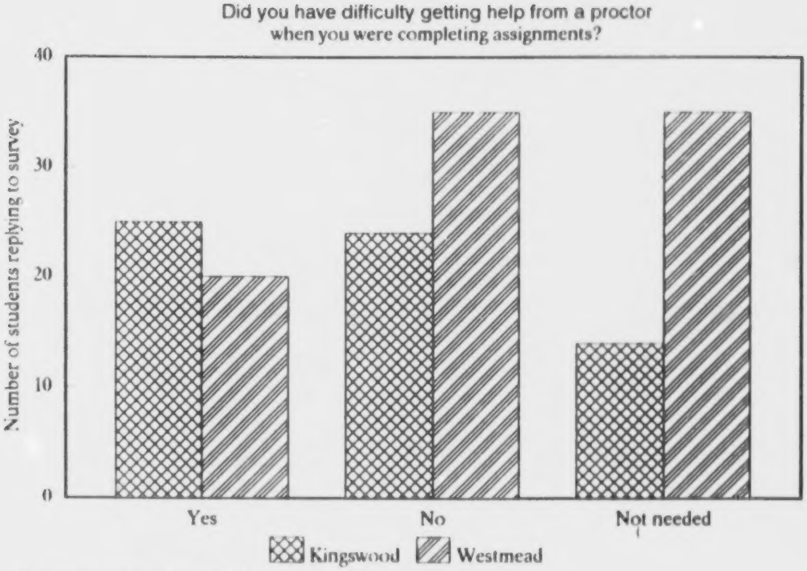
Assignments are graded as Pass or Unsatisfactory. The 'Student Progress Sheet' (Figure 5) illustrates how the assignments are checked off for either a Pass or a resubmission. Assignments that are unsatisfactory are returned to the students immediately for additional work (they are allowed one week) to get the assignment up to a passing grade.

Students' Perception of Assignments:

One per cent of the students who were surveyed felt that the assignments were too difficult, 32% felt they were difficult, 63% felt they were fair whilst 5% felt they were easy.

Figure 7 is a graph showing the student responses to the survey question 'Did you have difficulty getting help from a proctor when you were completing assignments?' It should be pointed out that a proctor was on duty in the Kingswood Personal Computer labs from 9 am to 9 pm five days a week and 9 am to 5 pm on Saturdays. This was a policy of the School of Science and Technology. At Westmead the writer appointed one proctor to the Personal Computer lab during the Information Systems I session time only. It is hoped that the Kingswood model will be adopted in 1991.

Figure 7



A proctor assigned to a PC lab all week at Kingswood
A proctor assigned to PC lab only during testing session at Westmead

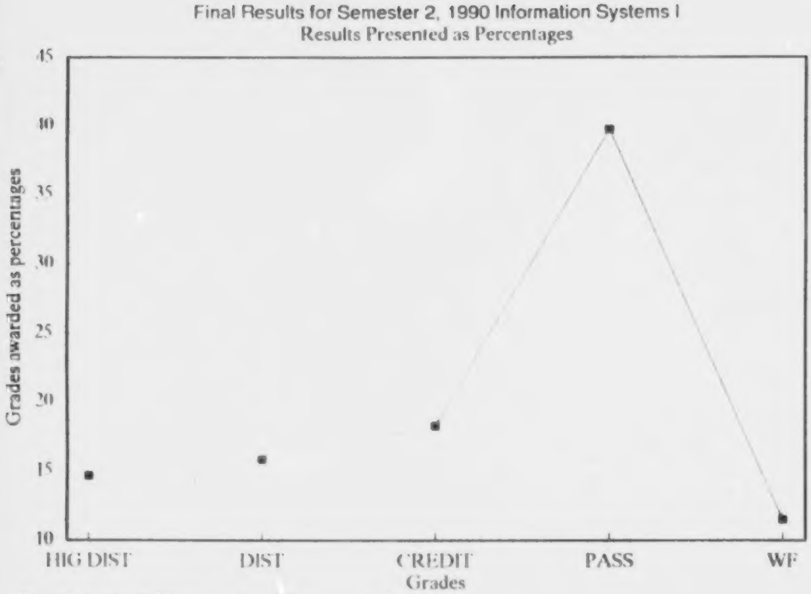
Results:

The graph depicted in Figure 8 shows the results achieved for Information Systems I during the second semester of 1990. Sample size was 252. It is interesting to note that there is not a normal curve. I quote from Bloom (1968)

'There is nothing sacred about the normal curve. It is the distribution most appropriate to chance and random activity. Education is a purposeful activity and we seek to have the student learn what we teach. If we are effective in our instruction, the distribution of achievement should be very different from the normal curve. In fact, we may even insist that our educational efforts have been unsuccessful to the extent to which our distribution approximates the normal distribution'[6]

Any student who failed to complete the course was given a WF for 'Withdraw fail'.

Figure 8



Results for both Kingswood and Westmead Campuses

CONCLUSION

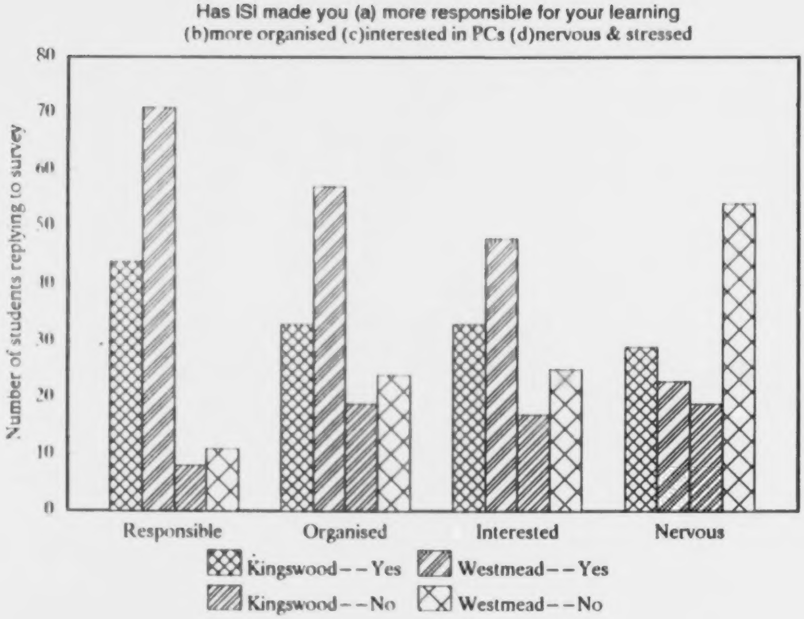
It has been an interesting assignment to be the course co-ordinator for Information Systems I at the University of Western Sydney, Nepean during 1990. The writer was encouraged by the surveyed students' responses to the following question:

Has information Systems I made you:

a) More responsible for your own learning
b) More organised
c) interested in computers
d) nervous and stressed

as illustrated by the graph in Figure 9 below

Figure 9



The implementation of PSI at the University of Western Sydney, Nepean has proven to be an efficient mode of delivery of Information Systems to the large student body. It has been efficient in terms of resources in that 1 lecturer and 4 proctors can service each 100 students. If the course was delivered via the normal lecture mode with say three assignments and a final examination there would be a need for tutors and other lecturers for tutorial sessions and marking of assignments and the final examination.

The writer also believes that it is an effective method of instruction in that students must study all sections of the core content of the course and not just the areas on which they wish to concentrate. Motivated students are not held back by less motivated students and indeed all are able to work at their own pace.

The writer's experiences would seem to confirm research findings overseas that show that PSI performance is equal to or surpasses most traditional lecture approaches and retention of information for PSI users also seems to surpass most other instructional systems.[7]

1. Robert S Ruskin, The Personalised System of Instruction: An Education Alternative, American Association for Higher Education, Washington 1974

2. Steven Mandell, Computers and Information Processing: The Complete Course with Basic, West Publishing Company, St Paul MN, 1989

3. Robert S Ruskin, op cit

4. Robert S Ruskin, op cit

5. Robert S Ruskin, op cit

6. Robert S Ruskin, op cit

7. Robert S Ruskin, op cit

INTEGRATION OF I.T.
IN BUSINESS/ACCOUNTANCY EDUCATION

by

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ABSTRACT

Our new Honours Degree courses in Business Studies and Accountancy, offered us an excellent opportunity to overcome our past constraints imposed by professional examinations. Better course structure and contents have been incorporated together with substantial improvement in computer applications. This article addresses the philosophy, direction and integration of information technology (I.T.) into business education as well as our problems and recommendations on running the course. We believe that our experience in running these new courses should be useful for training managers and academics in planning and running similar computer-based educational and training programmes for both managers/accountants and students in business and management studies.

Remark : The opinions expressed by the author in this paper do not represent the viewpoints of the Hong Kong Polytechnic nor the Department of Computing.

Background

The Division of Business and Information Systems at the Hong Kong Polytechnic consists of five academic Departments, namely, Accountancy, Business Studies, Computing, Hospitality Management, and Management. The number of Business/Accountancy degree places will reach 1,500 next year. The new honours degree programmes have offered us an excellent opportunity to plan our new Common Modules instead of following professional examination syllabus.

The Computing Environment

In order to incorporate a substantial amount of computing components into the business courses, the major investment in physical facilities has been in computer equipment, with more than 200 PCs for students, and over 100 PCs and some advanced work-stations for staff within the Division. Central computing facilities are also available at the Computer Center for the use of main-frame and mini-computers.

Philosophy, Direction and Integration of Subjects

Should computing be taught as separate subjects or whether it should be integrated within the (accounting/business) subject areas, where computing is of major benefit ?

This fundamental question reminds us of the philosophy of business courses which aim at 'educating' students to become business executives. Computer applications are incorporated throughout the degree programmes right from the start of year 1 but they are tools to assist managers/accountants to capture, store, process and interpret relevant information. The most important role of business executives is to make timely management decisions with his/her professional judgements based on the availability of quality information. Present-day managers and accountants should know the applications of computers but not necessarily to become computing specialists. They should be aware of their role in computing, their level of computing knowledge, and when to request services from consultants within/outside the MIS department.

The author suggests that some essential I.T. disciplines (such as the common modules described in subsequent sections of this paper) should be grouped as separate subjects, whereas some applications of I.T. may form an integral part of the core business subjects. Perhaps, it is more important to review the content of each I.T. subject, how the subject be taught and how it links to relevant business disciplines.

Common I.T. Modules

Due to the past constraints imposed by the subject syllabus in professional examinations, computing subjects were tailored to particular courses. Consequently, teaching effort were relatively high when staff were lecturing to smaller classes (typically 30-40 students) instead of mass lecture (up to 180 students at a time) and sharing of teaching materials, assignments, tests and examination papers was not at all possible due to the tailored syllabus for each I.T. subject.

The author believes that it is the right time to incorporate a modular approach to I.T. subjects (as well as other business subjects) for Business Degree courses in the Division. Three Common I.T. Modules can be considered as separate subjects :-

1. I.T. and Computing Tools (ITCT in Year 1)
   (30 hours lecture/seminar and 30 hours computer workshop)

   Objectives
   Students should understand the fundamental concepts in I.T. and computers, and be able to apply computing tools for solving simple business problems and for communication, presentation and reporting.

   Outline Syllabus
   - I.T. and data processing concepts supported by examples of computer application in business
   - Overview of computer hardware, software, input; output; and storage devices, systems development and programming concepts
   - Overview of file organizations, database, real-time and batch systems, data communication, networking and office automation
   - Computing tools (both Symphony or Microsoft-Works are currently used in the Division) : word processing, electronic spreadsheets, business charts, data (base) management, and integration of these tools.

   Integration
   In order to allow students to get early benefit of the application of computing tools, the ITCT subject should be taught in Term 1 of Year 1. Students can then apply computing tools such as spreadsheets and charting for solving problems in business statistics and accounting, or word processing for report writing. An accounting package (e.g. DacEasy) is used as an integral part of the subject "Principles of Accounting" because students should have hands-on experience in an accounting system package in order to appreciate the transaction-processing nature of book-keeping and accounting.

2. Information Systems in Organizations (ISO in Year 2) (30 hours)

Objectives

Students should be able to describe the application of I.T. in diversed business disciplines and be well-prepared for the role of an intelligent user in the systems development process.

Outline Syllabus

- MIS concept and components, general systems theory, and information concepts, impact of computer based information systems to business and management
- Roles of end-user and managers in Systems Development, corporate database, user procedures, user interface analysis, tools for systems development and documentation : data models, dataflow diagrams and systems flowcharts.
- Evaluation of application software packages
- Approaches to systems development : overview of SDLC, formal methods, prototyping and end user computing
- Specific application systems (with one/two systems tailored for a specific course) : e.g. Human Resource Management Systems, Accounting Information Systems and Financial Modelling, banking systems and EFT/POS, Marketing Information Systems, EDI and Forecasting Models, Production or Operations Management system and Hotel Management Systems.

Integration

After learning the pre-requisite subject on ITCT and the basic business subjects in Year 1, students can better appreciate the MIS concepts and application systems covered in ISO. Tailored software packages are planned for Taxation and Computer Audit. IFPS and SAS packages are being considered respectively for financial modelling and statistical applications.

3. Information Systems Management Issues (ISMS in Year 3)
(30 hours)

Objectives
Students should be able to evaluate the key management issues in the application of I.T. and understand the role of an intelligent systems supervisor/coordinator in a user department in the planning, developing and supervising the operations of information systems.

Outline Syllabus
- Overview of managing technology and people in the I.T. department
- Information systems planning for supporting business goals
- Competitive advantage and strategic information systems
- Information for management decision making, role of decision support systems and expert systems
- Systems security, controls and computer audit
- Social and legal aspect of computing, data protection

Integration
Students can further develop or evaluate I.T. issues as an extension of the ISO subject. Business strategic planning has to be supported by information systems plans.

Current Progress and Problems Encountered

The first common module has been adopted by the Accountancy Department since 1988 but all these modules have been modified and the revised modules (which are different from the above modules) would be used by all courses in the Business Studies Department and possibly one other course in the Hospitality Management Department from October 1991. The progress of the course will and some problem areas be described and evaluated :-

Staffing
Ideally, lecturers teaching computer applications should have good knowledge and experience in both commerce and computing fields. Since both finance/accounting and computing professionals are in great demand in Hong Kong, (as well as in Canada and Australia where more H.K. professional migrants tend to go), recruiting lecturers having business qualifications together with degree/masters and sufficient MIS background is extremely difficult. A joint teaching team consisting of academic staff from both Accountancy and Computing departments was tried. Through support by Staff Development Programmes, some Computing lecturers have obtained MBAs and some lecturers in Business and Accountancy have completed their Masters degree with major/minor in Computing.

Information Systems Group

A Information Systems Group (ISG) within the Division was established to promote computer literacy, identify MIS training requirements of internal staff, integrate computing disciplines into accountancy education and facilitate students' access to computers by the provision of computing resources and management responsibility for the operations of the Divisional PC rooms.

Teaching Methodologies

A combination of lectures, seminars, tutorials and PC-based workshops were applied to suit particular situations. Assessments on data processing concepts include open-book research essays, objectives tests and a written test paper.

Learning Microsoft Works

A 2-hour supervised workshop and additional self-practice session if required, are scheduled for 12 weeks in Term 1. After the first few weeks, most students can progress on their own pace with the self-learning module in Works. **Learning Guide on PC-based Microsoft Works** covering quick reference; supplementary worked examples and exercises on commercial problems were prepared by lecturers and used in parallel with the self-learning programme. The sequence of learning is : to work through the PC-based Learn module in Works, then follow the operations in the worked examples and attempt the exercises in the Learning Guide. Students find the learning approach as well as the learning guide effective in general.

PC-based Workshop Test

At the end of Term 1, all 290 students are required to attend the Workshop test in order to demonstrate their competence of using the integrated software package. Since we had bought only 75 copies of Works, we had requested the vendor to extend the copyright for over 140 PCs during examinations. The installation and subsequent removal of test software in more than 100 stand-alone PCs (with different DOS versions) was never a trivial task. Over 20 staff were involved in invigilation and the effort of assessment based on results on diskettes was quite substantial. Problems of examination security and corrupted diskettes (3 out of 290 in 1989 and none in 1990) were well under control.

Background of Students

Most of the 480 Year 1 students in business/accountancy did not have any prior computer/programming knowledge, while the minority got some experience with BASIC and WordStar. It is estimated that more than one-third of the students bought IBM compatible PC (mainly AT) at home by the end of Term 1.

Course Evaluation

An annual course review is carried out to collect valuable suggestions from both staff and students. The overall progress has been satisfactory so far. Nevertheless, some suggestions have be incorporated to these modules from year to year.

Conclusion and Recommendations

Managers and Accountants must now be able to assume a pro-active role in demanding for and making use of more sophisticated computer applications. In order to develop a curriculum to enable our students to maintain a sound balance of knowledge in business/accounting disciplines and computer applications, we consider integrating I.T. in business/accountancy education as an essential step. Course objectives, subject integration, physical and technical resources, staffing requirements and feedback of progress on students learning through continuous assessments and examinations must be carefully planned and monitored.

We hope that our observation and experience in integrating I.T. in business/accountancy education at the Hong Kong Polytechnic be useful for you (in particular training managers and academics) in planning and running similar educational and training programmes for managers/accountants and students in business and management studies.

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PREPARING *MIS* EXECUTIVES FOR THE 1990S

by

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ABSTRACT

Although more organizations begin to recognize the value of their information resource, very few of them are actually taking an active role in using information for both competitive advantage and improving organizational effectiveness. This does not only create vast opportunities for some MIS Executives (abbreviated as MISE) who can assume the new role of facilitating these rapid technological and organizational changes but also threatens others who are left behind on these strategic issues in MIS management. In fact, MISE are very unstable as their turnover rates are much higher than executives in other professions. Hence, developing managerial skills of MISE so that they could learn some new lessons about performing responsibly and effectively from an organizational standpoint in the 1990s has become a key issue in MIS management.

The six-stage training programs suggested in this paper are designed to improve the effectiveness of : (1) the MISEs as managers, (2) running the MIS Department as an effective business unit and (3) the evolving role and contribution of MIS to the organization.

The key issues of both managerial effectiveness and desirable management behaviour for MISE described in this paper should provide some very constructive ideas and practical skills to MISE seeking further improvement in assuming the demanding role of managing information technology, people and organization in the 1990s. These workshops and seminars should also contribute to the improvement of organizational harmony as well as the team cooperation and coordination within and outside the MIS Department.

1. Need for Developing MIS Executives

Although more organizations begin to recognize the strategic value of their information resource, very few of them are actually taking an active role in using information effectively for both competitive advantage and improving organizations' responsiveness to critical environmental changes (such as the impact of the Gulf crisis and the potential business opportunities in both Easten Europe and Asia). This does not only create vast opportunities for some MIS Executives (abbreviated as MISE) who can assume the new role of facilitating these rapid technological and organizational changes but also threatens others who are left behind on these strategic issues in MIS management. MISE face the greatest challenges and opportunities in modern organizations but at the same time they are very unstable as their turnover rates are much higher than executives in other professions.

Some MISE were brought up from the traditional career path of programmer, analyst, project manager and MIS manager. Most of their education programs centre around science and technology with emphasis on doing things right (according to user/lecturer specifications). As MIS takes on increased strategic importance, MISE must learn some new lessons about performing responsibly from an organizational standpoint [UR87]. In particular, the effectiveness or the extent to which MISE achieve the output requirements of their respective positions has become more demanding. Hence, developing the managerial skills of MISE has become a key issue in MIS management.

2. Training Programs for MIS Executives

The six-stage training programs for MISE are designed to develop the managerial skills of MISE in the following three major areas : (1) Individual Effectiveness, (2) Effectiveness of running the MIS Department and (3) Organizational Effectiveness as described later on. The sequence of these training programs by Stage is listed in Table 1 below:-

Stage	Name of Program	Duration (Days)	Refer to Subsection
I	Managerial Effectiveness Seminar	5	3.1
II	Team Building Workshop	2	4.1
III	Corporate Strategy Workshop	3	5.1
IV	Corporate Effectiveness Conference	0.5	5.2
V	Seminar on MIS as a Business	3	4.2
VI	Strategic IS Planning Workshop	3	5.3

Table 1 : Sequence of Training Programs for MIS Executives

Successful examples [ML85],[ML86],[CD85]&[MC88] indicated that practical approach for training MISE will be more effective. Hence, each training program is designed to start with either presentations on respective theories or briefings on specific issues in order to build up the relevant conceptual framework for the program participants. This is then followed either by a practical workshop or a seminar for the whole group or in syndicate groups in order to facilitate the experience of managers to be synergistically shared among the group(s).

Respective objectives, key result areas, duration, intended participants, and contents of each program are described as indicated by the subsection reference in Table 1.

3. Improving Individual Effectiveness

The 'Managerial Effectiveness Seminar' is the first training program designed to develop/improve the managerial skills of MISE through both better appreciation of their demanding role and practice of case studies on people management. This program is also suitable for managers other than MISE.

* Objective : To improve managerial effectiveness of MISE

* Key Results : Managerial effectiveness improved; Flexibility of management style increased; and preliminary objectives established.

* Duration : Five days

* Participants : All managers of the MIS Department

* Contents : Role and contribution of managers [RW85], Review of the manager's objectives and setting of individual goals [ML86]; Time management; effective delegation; motivation theories [ML84]; Inter-personal skills : assertiveness [ML87], effective communication and negotiation [ML86]; Management styles based on Reddin's 3-D Theory [RW70]; Relaxation & Stress Management [ML87]; Business consulting [MB8809] & organizational aspects of MIS; and Project management.

4. Improving the Effectiveness of the MIS Department

Effective team work and running the MIS Department as an effective business unit are essential to the overall success of the MIS Department.

4.1 Team Building Workshop

Since MISE and their subordinates are often working in (project) teams, building effective teams should be able to improve their productivity drastically. It is recommended that managers should attend the 'Managerial Effectiveness Seminar' prior to this program.

- Objective : To improve team role structure and cooperation

- Key Results : Team objectives established; Team re-organized if necessary; and Teamwork methods introduced and coordinated.

- Duration : Two days

- Participants : Each management team consisting of a superior and his subordinates who work as a team.

- Contents : Basic team building concepts; Team Decision case study; Team Skills management; Role analysis; and Effective meetings.

4.2 Seminar on Running MIS as a Business [ML85],[MB8807] & [DS85]

The MIS function was seen traditionally as a cost centre and its contribution to the organization has often been put down. However, modern organizations now recognize the need for managing the information resources in the same way as corporate assets - this has put tremendous pressure to MISE in running MIS as a business.

- Objective : To run the MIS Department as an effective business unit.

- Key Results : Policies on key Management issues of the MIS Department defined.

- Duration : Three days

- Participants : Middle & senior management of the MIS Department plus the immediate Boss of the MIS manager.

- Contents : Service level agreements & measurement of User Satisfaction; effect of Charge-back; End-user computing policies; Make or Buy policies; Integration of EDP/OA/Telecommunications; MIS Infra-structure analysis; Multi-vendor integration policies; Security & Controls; MIS Standards & Quality Assurance; Problem & Change management; Staff Productivity; and Information Systems Architecture [MB8810].

5. Improving Organizational Effectiveness

Top management support and commitment are essential to any programs on improving organizational effectiveness but most MISE encounter difficulties of identifying top management objectives [LM86], which are the basis of developing long-term information resource plans. Hence, the Chief Executive Officer (CEO) should be convinced to direct the use of MIS to improve an organization's effectiveness : (1) by aligning MIS throughout the firm to provide consistent "indicators" that reinforce and further the CEO's strategic objectives for the business and (2) using MIS to directly support and leverage the effectiveness of managers, professionals and staff [GT85].

The following training programs are designed to improve the organizational effectiveness in the management and application of information resources :

5.1 Corporate Strategy Workshop

Since the existence of MIS is to support the business and management functions of the organization, the MIS plans must support the corporate missions and business objectives.

* Objective : To improve organization policies and design

* Key Results : Organization diagnosis made; Organization policies reconsidered - Mission statements refined and new goals might be established; and Organization structure reconsidered.

* Duration : Three days

* Participants : All heads of Department and the CEO

* Contents : 'SWOT' analysis for evaluating the Strength, Weaknesses, Opportunities and Threats of the organization [ML86]; Creative strategic planning; Organizational structure; and Corporate Culture.

5.2 Corporate Effectiveness Conference

This conference is designed to enhance/further the commitment of managers on the corporate objectives and policies, which have already been defined in the 'Corporate Strategy Workshop'.

- Objective : To improve organization wide commitment.
- Key Results : Corporate objectives and policies clarified; Objectives and policies accepted; and Influence of the CEO strengthened.
- Duration : Half day
- Participants : All heads of Department and the CEO
- Contents : Corporate mission; long-range corporate goals; and corporate policies.

5.3 Strategic Information System Planning Workshop

Results of 'Corporate Strategy Workshop', 'Corporate Effectiveness Conference' and 'Seminar on MIS as a Business' are major inputs to this workshop.

- Objective : To ensure that MIS plans support business objectives and to promote a general understanding among corporate management staff of the role and contribution of MIS.
- Key Results : Corporate information requirements defined; Information Systems Requirements defined & prioritized; and Long-range MIS plans defined.
- Duration : Three days
- Participants : Steering Committee and senior managers of the MIS Department.
- Contents : Business Strategy analysis; Technology analysis; Organizational learning; Use of Information for Competitive Advantage; The four-stage model of MIS planning [DW85] & Organizational information requirements analysis methodologies (e.g. BSP, CSF & E/M etc.); MIS funding & staffing policies; and Alignment of MIS in the Organization.

6. Conclusion and Recommendations

The key issues of both managerial effectiveness and desirable management behaviour for MISE have been described in respective training programs, which should provide some very constructive ideas and practical skills to MISE seeking further improvement in assuming the demanding role of managing information technology, people and organization in the 1990s. These workshops/seminars should also contribute to the improvement of organizational harmony as well as the team cooperation and coordination within and outside the MIS Department.

Executive development is an on-going program for any manager. There is no definite guidelines as to how long each program should take though it is recommended that each manager should at least spend 2 weeks per year on training programs of either functional management or general management [ML86] in order to keep up with the new developments of their specialized field of expertise or responsible functions.

In order to remain effective, MISE must continue to evaluate and benefit from the impact of new developments in both information technology and management. This can be achieved through reading good professional/management journals and attending relevant seminars/workshops and training courses. It is hoped that there would be more training programs/publications on the development of managerial skills for MISE in order to assist them to confidently face the challenges of managing MIS resources and organizational aspects of technological changes.

The authors will continue to develop these training programs initially in Hong Kong through the Hong Kong Polytechnic and the Hong Kong Management Association and then (hopefully if they become more popular) extend these courses to Asia, Australia and other countries.

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INFORMATION TECHNOLOGY CHALLENGES FOR TRAINING IN THE LARGEST QUEENSLAND BASED BANK

by

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Metway Bank

ABSTRACT

The competitive deregulated environment of Australian banking requires a strong commitment to ongoing technological advancement. This paper discusses the strategy employed to manage training in the three main areas where training and technology work hand in hand. The three areas are discussed under the following headings:

- Training banking staff in the use of information technology.
- Using technology to train staff in banking procedures and products.
- Ensuring the ongoing professional development of staff in the Computer Services area.

Metway requires staff to be both willing and able to provide the very best in customer service. Much of the effort of the Metway Training Centre encourages staff to be willing while the author concentrates on their being able to provide this standard of service. The applicability of Computer Based Training to the banking industry is discussed along with the need for staff to be trained in the effective use of personal computers.

THE BANK

In these difficult economic times it is a pleasure to be able to report on innovations by a successful Australian company. With a network of 110 branches throughout Queensland and northern New South Wales, Metway is growing rapidly and returning the highest profit of any bank in Australia. The key to this success lies in certain core values the company identifies and promotes as being vital in gaining respect and support from the community.

- Respect for the Individual
- Ethical in our Dealings
- Value for Money
- Quality Service
- Quality Products

All activities in Metway can be closely related to these values and training is no exception.

CHALLENGES IN TRAINING

With staff working in branches spread from Cairns to Coffs Harbour and in the Head Office where a wide range of skills are employed the challenges to training are quite daunting.

Newly employed staff attend orientation training and customer service training at the Metway Training Centre in Brisbane. On going training in new products and procedures for branch staff is facilitated by Regional Training Officers. This system works well because of the commitment of all staff to make it a success. It is however, both labour intensive and expensive. The author is responsible for identifying the means by which Computer Based Training can ease the burden on Regional Training Officers by providing and monitoring most of the training in products and procedures leaving the R.T.O free to concentrate on the people related skills which are so vital to providing excellent customer service. The C.B.T. system must provide reports to the R.T.O.'s and managers of the progress of staff through the training modules.

By providing personal computers to most staff the bank is committed to providing a high level of training to staff in wide variety of occupations in order to obtain the benefits of high productivity which the personal computers can bring about. Computer professionals have a wide variety of specialist training needs which must be monitored and catered for in order to enable them to stay abreast with the rapid technological changes in their area.

The Metway Training Centre provides a wide range of managerial and personal development training activities and services to staff however this paper will concentrate on training activities in which there are technological implications.

TRAINING IN THE USE OF TRANSACTION PROCESSING SYSTEMS:

All terminals used for transactions in Metway braches are I.B.M. PS2 work stations. This enables sophisticated from end processing to be carried out at the point of transaction while enabling user friendly screens to be presented to Customer Service Assistance (called tellers in the older banks). This front end processing package which is referred to as the

ACCESS system was designed by Metway staff and is readily adaptable to incorporate new procedures and products. Detailed training is given to all new staff in the use of the ACCESS system and all system changes are accompanied by appropriate retaining. It is in this area that C.B.T is envisaged to play a pivotal future role.

TRAINING IN THE USE OF P.C. BUSINESS PACKAGES:

Business packages such as Lotus 123, WordPerfect,dBbase IV and similar software are used extensively throughout the administration centre of the bank. Future expansion in the use of these packages is planned both in the administration centre and into the branches as well. The management of this training requires the monitoring of external suppliers who can provide the standard and type of training required. This training can be broadly classified into two categories. These are as follows:

Reactive Training

This type of training is largely outside the day to day control of the Computer Training Co-ordinator. If a P.C. is installed in an office somewhere with such packages as WordPerfect and/or Lotus 123 then staff in that office will immediately require the appropriate training. Computer training staff must recognise this situation and react by providing timely and effective training in the products involved. There is a need for computer training staff to be involved in the setting of the implementation program for P.C.'s and associated software however this is not always easy to arrange.

Proactive Training

This type of training requires staff to keep up to date as a computer professional and then implementing training programs for P.C. users to bring concepts to their attention which otherwise may be overlooked. Training courses which are typical of tis typed of training include: P.C.'s for Managers which gives managers the opportunity to understand the technology their staff are using and Database Design which enables staff who use database packages to create more efficient databases.

The selection of staff to attend any type of P.C. training is generally more difficult than is the case for other types of training since both manager and nominee are unaware of what it is that they need to know.

MANAGING THE TRAINING OF COMPUTER PROFESSIONALS:

Within any large organisation is a group of computer professional who provide the means and indeed the leadership under which the corporate computer policy can come to fruition. Inevitable staff of this type require technical training of a high level and frequently only very few staff require training in any particular topic. As a consequence, the cost of finding providers of this training as well as its delivery is considerable greater than the provision of more "routine" training. Computer professionals as a result of their background are sometimes found to be rather ignorant of the business of their employer. It becomes necessary to provide computer staff with training in the business of banking in order to ensure that their technical skills are appropriately channelled.

Metway had developed a skills based training plan based on a detailed database of the skills inventory of all computer professionals in order to monitor and co-ordinate their training.

COMPUTER BASED TRAINING

There would appear to be a perception in certain areas of the training profession that Computer Based Training is the panacea to all the ills in the corporate training area. This is far form the truth. There are clearly many areas where C.B.T. is less effective that other means. Management training where carefully orchestrated group interaction reinforces the concepts being taught is an example where C.B.T. has little to offer. C.B.T. offers an increasingly cost effective training option with increased student satisfaction as more of the following factors describe a training situation:

- The number of persons to be trained is large
- The persons to be trained are geographically widespread
- A variation in aptitude exists between potential students
- Student progress needs to be objectively tested and monitored
- The subject material is not subject to frequent change
- The subject material does not contain ambiguous or emotive material
- The subject material does not require large cognitive leaps in understanding
- Subject experts are available to answer queries and to offer encouragement
- P.C.'s are available to all staff requiring training
- A network exists whereby training packages can be efficiently distributed and results collected

There is no doubt that the banking industry and Metway in particular with its sophisticated ACCESS system meets all the above criteria. This was recognised some years age when the initial planning for the ACCESS system was commenced however the implementation of C.B.T. was held over to this year so as not to overtax available resources. It was felt that for the C.B.T. program to offer ongoing stability, confidentiality and responsiveness to user needs, the expertise in authoring must reside in the bank. To date the networking implication have been identified and an evaluation of authoring packages had been carried out. A pilot training package had been developed and circulated to many braches and other appropriate staff for comment. These comments will influence the format of future packages.

Computer Based Training (C.B.T.) is an umbrella term which includes the processed of Computer Aided Learning (C.A.L.) and Computer Managed Learning (C.M.L.). The process of C.A.L. refers t the authoring and presentation of training packages which are run on computers with students receiving individual self paced training. The C.M.L. process refers to the computerised monitoring of student progress. Through C.M.L. reports on individual student progress as well as overall statistical information can be generated in whatever format is considered necessary for students, administrators, and managers. Whilst Computer Aided Learning (C.A.L.) is a key factor in the C.B.T. program it is felt that Computer Manager Learning (C.M.L.) must work as an equal partner in the process. Consequently with distribution of the pilot C.A.L. package within a Metway a C.M.L. system will be established over the network to monitor staff who use the C.A.L. package. This will enable reports to be sent to appropriate staff so that support can be given to any staff member who encounters difficulty and to recapitulate on the material with staff as they successfully complete a module.

CONCLUSION

Metway has had a commitment to the extensive use of information technology in training and education and will maintain this commitment in the future. The growth and profitability of the company would be considered remarkable by any standards but more so in the present economic climate. The cost of putting this commitment into practice is high but the rewards through presenting our customers with committed and competent staff are considerably greater.

EDUCATIONAL OBJECTIVES AND THE INTRODUCTION OF COMPUTER AIDS FOR TEACHING IN TERTIARY EDUCATION

by

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ABSTRACT

It has been commonly observed that educational objectives have not always been given sufficient consideration at the time of introduction of computer aids to teaching in tertiary education institutions. This paper examines the nature of educational aims which have influenced the development and use of computers in teaching of statistics and design (separately) in RMIT at the Victorian University of Technology.

The papers start from the position that it is important to understand the institutional and educational context. Issues which influence the type of educational objectives and the importance given to them are explored. The research identifies different perceptions of the role of computers in course delivery. Directions for change are proposed with the intention of improving the level of debate in academic institutions.

1 Introduction

In RMIT at the Victorian University of Technology there is the common impression of heavy expenditure on micro computers to help in the teaching task. The investment is readily apparent in high profile Department, Faculty and recently, campus laboratories. The new technology has effectively taken on a life of its own. Laboratories can be powerful symbols to government and industry serving course-related political and financial ends. Courses have been amended to introduce computer related material. Staff gain power and authority based on their association with these components of courses. Committees, support staff, maintenance services, expenditure processes have been established to manage the computer facilities. There is a new vocabulary in budget committee discussions. New tactics have emerged in the fight for Facility funds (" but, I hadn't realised we had all this hardware and no programs to run!")

What has been achieved in these five years? Have these computers actually been used in the courses? If so, how? Are all courses using computers equally and in similar ways? Most important, has the introduction of computers improved the quality of learning experienced by the students?

This study seeks to answer these questions albeit in a general manner. It draws on the experience of a limited number of courses all in this one learning institution, RMIT.

The study examines staff views on the role of computers in education in two fields - design and statistics. The intention has been to expose underlying perceptions of academic staff. We expect that these views would have been strongly influenced by the experiences in recent years. We also expect that they would play a major role in shaping how computers are used in the next few years.

2 Study method

A case study approach to the research has been adopted. A basic assumption is worth highlighting: it is valid to classify views of staff in the different design disciplines and, separately, in the different fields of statistics application. The study left open the possibility that experiences in two contrasting disciplines could reveal common lessons.

At the time of writing 21 interviews with current and past RMIT staff have been conducted. In design:

Architecture (two academic staff)
Interior Design (3)
Landscape Architecture (1)
Industrial Design (2)
Fashion Design (2)
Textile Design (1)
Visual Communication (2)

The interest, for the purposes of this study, has been on the use of computers for the teaching of 'creative' design, that is, the conception and development of an idea for an image, product or building.

Statistics is taught as one subject or a sequence of subjects in a range of courses. The emphasis have has been on the teaching of basic descriptive and inferential statistics. Interviews have been held with lecturers in:

Department of Mathematics (two current and one previous staff member).
Department of Applied Economics and Finance (1)
Graduate School of Management (1)
Department of Social Science (3)

All interviews have been interviewed and transcribed. This paper quotes directly from several conversations.

The interviews were structured as follows:

- What is your role in the course?
- How have you used computers in your educational programme? An alternative approach was sometimes more appropriate - how have you had experience of students using computers in your course? (Usually

the interviewee felt a need to explain hardware, software, the nature of the computer 'subjects' and sometimes the history of computers in the course.)

- How do you perceive the role and value of the computers in the course? (Probed for underlying views, clarification of terms, advantages and disadvantages.)
- On what basis have you developed these perceptions? (Probed for basis of views, whether it is experience based or related to some formal evaluation.)

Academic staff members who have been responsible for computer use in the course were selected for the interviews. These people tended to be advocates of the use of the technology both in their profession and in teaching for the profession. Several interviewees have only worked with students who used computers introduced in another part of their course. One person has been interviewed because of an avowed scepticism of the value of computers. Tutors through to Senior Lecturers and a Dean were interviewed.

3 Actual use of computers in courses

It is clear that actual use and experience of computers in courses has been varied and in some cases quite limited. Computers have only been used effectively in most student studies for the past two or three years.

The implications need to be recognised. First, often computers have only been introduced in single subjects and in some cases only single assignments/class exercise (Fashion Design, Textile Design, statistics in business courses.) There has not usually been an opportunity to build a structured sequence of subjects which introduce computers in the curriculum over several years of student studies. A prominent exception is the computer aided design (CAD) electives on offer for Interior Design and architecture students.

Second, staff in half the courses have not had real opportunities to learn from past teaching experience over several years. Lecturers are still developing their ideas.

A claim is often made that there are simply not enough computers for student access. This is seen by several lecturers as a problem of computers in their educational programme. It almost seems to become the problem, not the use to which the computers are put.

An inadequate number of computers may 'force' lecturers to adopt teaching strategies which they recognise are inappropriate educationally. One design subject lecturer admits to encouraging students to develop ideas away from the computer: "in some circumstances students..... luxuriate in front of the machine being in interactive mode, and we try to discourage that.... mostly for resource reasons". This runs counter to the studio approach to design teaching which is strongly held as an ideal by many design staff. The same lecturer: "at the end of 1985 [when the first computers were being introduced] we had already concluded that, resources permitting, this ought to be a technology that was a peripheral available in the context of a design studio". The studio encourages students to develop designs on the spot.

4 Staff awareness of, and skills in, computers

It is also important to acknowledge that many staff in design have little computer 'awareness'. Further, lecturers knowledge of, and skills in, computer applications in their industry is being developed in conjunction with their use of computers in the course.

Computer applications in design courses are typically being led by an individual staff member who is deemed to have an interest and expertise in computer applications. This interest tends to be focussed on the computerisation of industry, not education. The individuals may have been given explicit responsibility to introduce computer applications (Fashion Design, Textile Design, Industrial Design, Visual Communication). Other staff are only slowly being introduced to computers.

Staff in two courses agreed that student work with computer applications was in part helping them explore the value of the technology to their industry.

The division of skills (most staff do not have computer skills, a prominent few do) creates a division within the staff contributing to a course. This is not necessarily a problem provided lecturers develop a consensus on how computers should be used (Industrial Design, Visual Communication). However, there is clear evidence of no real staff debate about the educational role and value of computer technology (no design course had seriously debated this issue). Some staff, when approached for interview, claimed they probably would not have anything to contribute to this study - they suggested instead we contact the staff member responsible for computer applications. It is reasonable to hypothesise that the division of staff responsibility and worse, this way of thinking, potentially reinforces a technological rather than educational orientation to computers. Lecturers who regard themselves as computer 'illiterates' or even 'Luddites' - several architects used the latter term-tend to lack willingness or confidence to enter debate on the topic.

5 On what basis do staff form their views about computers in their course?

No lecturer, including the many active proponents of computers, had systematically evaluated (in the formative sense) computer effectiveness in teaching and learning in their courses. Many admitted they had not rigorously studied the literature on the role of computers in practice or education.

The views of computers in education (and principles which governed application of computers) have evolved from:

- general experiences as an academic (reading, observation of the other courses, contact with industry).
- personal experience when the academic was a student.
- observation of students and students' work with computer based exercises in class.

It is worthwhile to note that those who are sceptical about computer value in education are no different in this respect from those who are committed to the technology.

6 Design lecturers' perceptions of the role of computers in their courses

A tool

Design lecturers conceive of the computer (including mouse and some form of paint software) as an alternative medium for developing design concepts. Other media include paper and pencil, pen or brush with palette, modelling with foam or other material. The issue then is how a designer uses these tools: "The computers are tools like a paintbrush or the palette. That is all they are. They are tools that will do absolutely nothing unless you tell them to do it. So if you want a good product you still have to be creative, if you want a good design from the computer you still have to be creative..... The computer won't make you a good designer or a better designer".

Computer drawing packages are seen to help promote "design thinking", "visualisation skills" and "conceptual development". The advantages of the technology include:

- quick construction of images, with colour and three dimensions depending on the software.
- ready amendment and mistake correction.
- creation of various of images and different views of images.

Such a facility permits student manipulation and exploration of design ideas which are seen to be fundamentally valuable ways of designing (and learning to design).

We will leave aside for the moment the design courses which have not yet implemented a full computer element according to some structured principles. There are two contrasting teaching approaches to realise the benefits. Industrial Design and Visual Communication favour using simple drawing packages (wire frame images for three dimensional work if necessary) to prepare designs within core subjects from year one. Final year students are encouraged, but not required, to explore designing with computers in major projects.

Interior Design and Architecture on the other hand have a sequence of separate electives. Two subjects start with introductions to computer operations and CAD concepts. Computer aided design skills are built up over the remaining four electives culminating in detailed three dimensional geometric design, rendering and animation. A feature of this programme is the use of a CAD package which dominates professional practices.

A comment is offered by the author at this point. The second approach may not help students to fully appreciate the computer as a design tool which is an important aim of the lecturers concerned: there is a considerable learning curve; electives with a technological focus do not help students compare different media; assessment tends to concentrate on mastery of the package rather than design; and, because the electives are offered to a range of courses, lecturers may have limited skills in the design field of interest to the student.

Limitations of the computer as a design tool

The advocate of the computer as a tool to aid design can readily accept that the technology has its limitations. These limitations can be seen to be in two general categories. The inability of a computer software and hardware configuration to achieve a certain effect is the first category. A commonly cited example is the restricted type styles and spacing options available. Other examples are the poor quality rendering of surfaces of drawn three dimensional objects and the difficulty of varying the width along any single line.
One response to this problem is to effectively discount these limits: they are relative only to a specific paint package. If you are prepared to pay more or as technology develops these limits will become less and less significant.

The more common response, however, is to acknowledge that computers have real disadvantages as well as advantages for designing. Students need to gain an appreciation of these capabilities and the limits of the technology (which may, indeed, be specific to a design task). Students ultimately must be able to consciously compare the different media and if necessary, reject the computer in favour of another medium to achieve a desired effect.

A second category of limitations relate to the assumptions which are inherent in computer technology about design practice. Half the lecturers in varying ways accepted that packages reflected particular approaches to design. Some proponents of computers admitted that most two and three dimensional drawing packages support a geometric, repetitive style of design. Others felt that computers tend to reflect a mechanical, logical approach to design. The sceptic agreed that computers have reinforced a "systems thinking" and "rational method" approach to landscape site analysis and design, both of which have fallen out of favour in the profession.

Lecturers who accepted these views had one or both of the following responses. First, the computer geometric style of design was suitable for certain tasks - this view has been discussed above. Second, the technology would appeal to some students who may legitimately take it up as their main medium for expression. Other students, equally legitimately, may decide to reject computers entirely.

7 Statistics lecturers' perceptions of the role of computers

Statistical analysis packages such as Minitab are dominating computer applications in the teaching of introductory statistics at RMIT. However lecturers perceive such packages as fulfilling somewhat different roles in their teaching. Two general perceptions have been identified.

The first distinguishes statistical theory and application of statistical method in practice. Lecturers who offer service subjects for courses with which they have no other tie, tend to make this dichotomy explicit. Computers are generally seen to be of value for the learning of statical analysis procedure and practice but not for understanding statistical concepts.

Within this class of perceptions two positions - perhaps suggesting a continuum - can be discerned:

1(a) Computers are a required tool for analysis. Students must acquire the skills which will enable them to conduct appropriate analysis. Examples of these skills are checking data after entry and verifying assumptions.

1(b) Computers provide an opportunity to adopt a more mathematically valid approach to statistical analysis. According to this view the process of analysis has effectively been changed by the arrival of the computer. Curriculum can be restructured to concentrate on verifying assumptions, exploring and transforming data.

A characteristic of both positions is the strong advocacy of a theory based subject for one semester prior to the introduction of a computer analysis package in second semester.

The second general perception clearly sees a role for a program such as Minitab in helping students develop basic statistical understanding. Theory and application are not separate. Computers are a tool for teaching - equivalent to, say, lectures or tutorials with exercises. As before, two positions suggesting a continuum of views can be identified.

2(a) Understanding of statistics requires an appreciation of the need for, or purposes of, statistical techniques. More realistic data sets, with many cases and variables, can be readily analysed with computers. Small data sets have limitations from a teaching point of view: "if you can see a comparison between two things .... (say).... you have got men versus women on a particular issue and you can look at it and without using any statistical analysis mechanisms you can say, oh well, men are obviously like this. Then that doesn't help the business of why statistics are useful. Statistics are useful because the data is not as visible as it is in small groups".

2(b) An analysis package can be used more explicitly in a focussed manner promoting understanding of statistical concepts. The teacher "is trying to get away from the mechanics of the exercise and really focus on concepts. They (the students) still have to understand the basic idea of what a mean is, but they are not tied down to a formula". The emphasis is on meaning and generalisation rather than formula and calculations. The computer is beneficial because, for example, it handles all the calculations, enables real data to be used and permits ready recalculation with and without outlier (of value in appreciating the difference between such basic concepts as mean and median).

Data analysis with a statistical package is integral to the teaching according to this class of perceptions. Computers are used at the time the basic concepts are discussed in class. One course at RMIT schedules each week, a one hour lecture, one hour tutorial and one hour computer laboratory session which indicates its commitment to integration of computers.

8 Conclusions

We started this study with the aim of exploring the quality of education. Reviewing the findings outlined above we can come to the following general conclusions.

Many courses are clearly in the early stages of assessing the value of the computer technology for both industry and education related purposes. Academic staff should be encouraged to develop their own reasoned positions.

The discussion in section 6 and 7 above reveals a range of perceptions about the nature and purpose of computers in specific disciplines. Making these perceptions explicit is the first step in promoting a more reasoned debase in a course context. It suggests the focus of this debate should be on such questions as the nature of practice in the discipline, the extent to which computers are tools and the key aims of education. Narrow discussions on technology, even the potential of future developments in hardware and software, are to be avoided.

All staff in a course should be involved in the discussions which could lead to a coherent and educationally relevant set of principles to guide the use of computers. This study found that lecturers who lacked any computer skills are able to present a reasoned position even if it is just based on close observation of student work.

Academic staff in the few courses which have had an opportunity to deliver a complete programme incorporating computer applications can display quite different appreciations of the nature of the computer contribution to their profession and teaching. Yet apart from informal and casual discussions in the staff room, no evaluation is planned. It would appear appropriate to review experiences to date, make comparisons with like courses and promote the kind of debate described above.

TESS: TOTAL EXERCISE AND DIET SUPPORT SYSTEM

by

Keizo Nagaoka
Emiko Kimura
Toshiko Hosokawa
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and
Maomi Ueno

ABSTRACT

There is a great demand for exercise and diet among the young generation, but ere is seldom success in the process. One of the major reasons is the retention of their will. This CAI system has been developed for a continuous performance of exercise and diet using multi-media, and some favourable results have been obtained.

Key Word : CAI, Multi-media, Exercise, Diet

TESS: TOTAL EXERCISE [illegible]ND DIET SUPPORT SYSTEM

by

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1. Introduction

TESS (Total Exercise and Diet Support System) is a computer- supported multi-media CAI system for excercise and diet. The object of TESS at present is females in their twenties, who are most interested in exercise and diet.

The characteristic functions of TESS are as follows:

1)Multi-media CAI system

It is effective for presenting information by video and sound which is difficult to express in writing. We dealt with the presentation of movement of exercise and scene of dietary cooking by multi-media, which can hardly be expressed in writing.

2)Totalized guidance for exercise and diet

Although there are many computer program packages and video cassettes for exercise and also program packages for diet includung guidance on cooking and nutrition, they aim at exercise and diet almost independently. From the view point of calorie input/output
(supply and consumption), the two can be dealt with simultaneously and effectively.

3)Teaching of Essential Knowledge

TESS can provide the users with the instruction on the essential knowledge and the keeping of a diet diary for continuing correct exercise and diet.

According to our investigation, many people also in Japan, especially young females, have a desire for exercise and diet, but the users have hardly ever accomplished their purpose, mainly because of the lack of correct knowledge and the will to continue. Teaching of the essential knowledge and keeping the diet diary are very effective for supporting their continuing exercise and diet, and this system is perticularly suitable for these functions.

2. Investigation for Diet

The authors investigated with questionnaires on diet to twenty-five female university students who were all in their twenties, and obtained the answers in these three categories:

1) Consciousness for diet
2) Knowledge of diet
3) Actual condition of diet

As to 1), they have a strong interest in diet (percentage of positive answers was 92% : the same in the following), want slender figures as the goal rather than the standard figure corresponding to their height by attaching more importance to the looks and the shape of body than health(56%), and think that the major reasons for not succeeding in continuation are the temptation of food (60%) and the lack of will (32%). The part of body where they wish to become thinner is "leg"(46%).

As to 2) and 3), they have relatively much knowledge but many of them are not correct(56%), and only a few of them did both exercise and diet in an integrated way, or totally, and even fewer did calculations of supply and/or consumption of calories(8%).

From the above results, we become further aware of the demand for a new diet method and the necessity of a computer-supported system for teaching correct knowledge and assisting diet totally and continuously.

3. Construction of TESS

The construction diagram of TESS is shown in Figure 1. The left side of the diagram in Figure 1 is concerned with exercise, and the right side is related to diet. When using TESS for the first time, the user has to start from the title block, and for the second time and after she can chose any block of exercise or diet.

The main blocks in Figure 1 will be explained below :

a) Consultation on Diet

This block consists of the indication of the standard figure and the diagnosis of the fat type. In the former, the figure of the user's standard body is calculated from her height and indicated in comparison with her ten input measures : height, weight, upper arm, upper bust,lower bust, waist, hips, thigh, calf and ankle. In the latter, three diagnoses are executed : for psychology of being overweight, internal medicine related to overweight persons, consciousness of facial appearance. The diagnoses consist in 66 questionnaires, and the users are classified into eight types as follows :

A) Slim and beautiful
B) Serious about weight and stay slim
C) Worried about weight but do nothing about it
D) Not even worried about weight
E) Are in irresistible environment to be overweight
F) Morbid character leading to be overweight
G) Too nervous to succeed in weight control
H) Worst character to be overweight

After the indication of these types, a prescription corresponding to each type is presented, i.e. advice like the possible causes of overweight, for points improvement, and so on.

b) Diet Program and Menu

Corresponding to the classification by the above consultation on diet, concrete diet methods are indicated to the user concerning sports, amount of meal, content of meal, bath, sleep and the other matters related to the whole daily life.

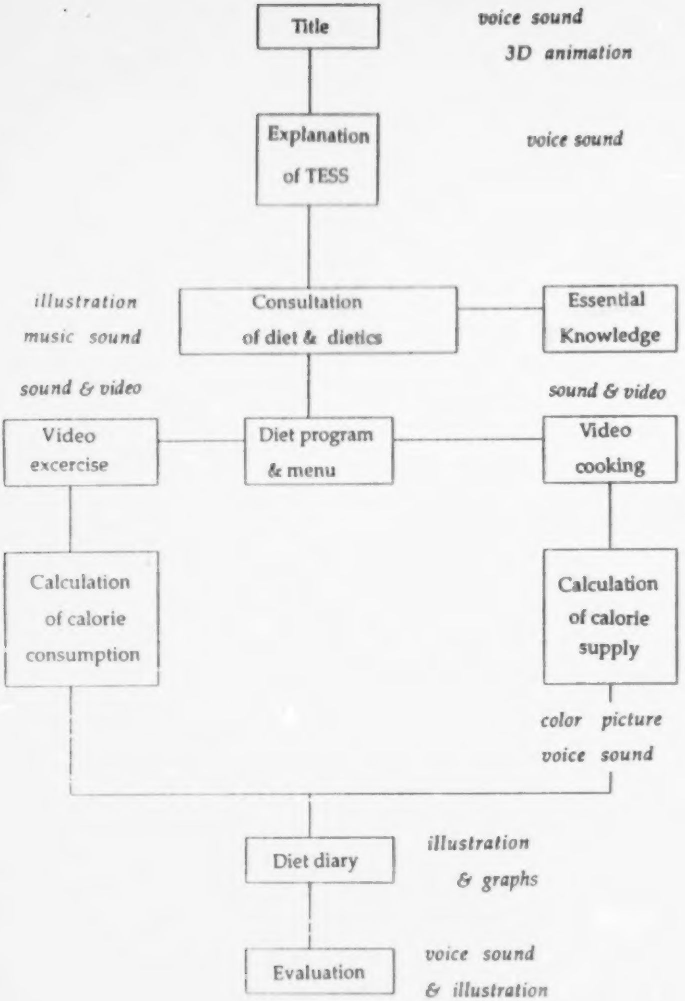
Title
voice sound
3D animation
Explanation of TESS
voice sound
illustration
music sound
Consultation of diet & dietics
Essential Knowledge
sound & video
sound & video
Video excercise
Diet program & menu
Video cooking
Calculation of calorie consumption
Calculation of calorie supply
color picture
voice sound
Diet diary
illustration & graphs
Evaluation
voice sound & illustration

Figure 1 Construction Diagram of TESS

(*Italic* words indicate using multi-media in the block concerned)

c) Essential Knowledge of Diet

The users are asked in this block about the essential knowledge of diet in 25 questions and answers.

d) Video Exercis

This block is a core of the system which provides to the users seven categories of exercise : aerobics, walking, aerobike, jazz dancing, stretch bench, stretch, partialized aerobics. The partialized aerobics is divided further into ten items : thinning the body, making the arm slim, and so on.

4. Execution of TESS

Nine female university students all in their twenties used TESS. They were not familiar with operating the system.They were observed while they were using the system,and their expressons of TESS were recorded.The result is shown below.

1)Effect of presentation by multi-media

Reactions of the users to sound, animation and video are very great and favorable. The presentation by muti-media is effective perticularly for information which can hardly expressed in writing : e.g. the amount of meal can be shown by color picture with the sense for the real, and the users can exercise with the movement of instructer in the video

2)Calculation of calories

The consumption and supply of calories are automatically calculated in TESS, so there is no confusion and mistake in the procedure of calculation for the users

3) Easy operation

Although the users were not familiar with operating the system, there was no problem to execute TESS.

4) Supporting for continuous exercise and diet

The function of diagnosis and advice in this system can give the precise goal and the correct process to it for the user

5) CAI

TESS is not only a support system for actual exercise and diet, but also a CAI system which teaches effectively and efficiently the correct knowledge of exercise and diet.

5.Result

The authors developed a CAI system for a continuous performance of exercise and diet using multi-media. The functions of this system are shown below:

1)Presentation by multi-media
2)Calculation of calories
3)Friendly user interface
4)Supportiong for continuous exercise and diet
5)CAI which teaches the correct knowledge of exercise and diet

And young women used this system in practice. In result, their reactions to this system were very favorable.

PRODIGY: AN INTELLIGENT COMPUTER-BASED SYSTEM FOR DEVELOPING TEACHERS' EXPERTISE IN THE DIAGNOSIS AND REMEDIATION OF COMMON ERROR PATTERNS IN THE DOMAIN OF COMMON FRACTIONS

by

Rod Nason

ABSTRACT

This paper describes the architecture and functioning of PRODIGY, an intelligent computer-based production rule simulation system which has been designed for use in University-based mathematics education courses and TAFE-based adult education courses.

The major aims of PRODIGY are:

i. to develop diagnostic and remediation expertise in pre-service and postgraduate mathematics teachers
ii. to help teachers gain deeper insights into how students learn and mislearn mathematics; and
iii. to help adult learners gain deeper understandings of the mathematics they are learning

To achieve these aims, PRODIGY presents the users (ie teachers or adult learners) with simulated case studies of learners who are experiencing specific problems with the addition of fractions. The users are required to diagnose and remediate each of the case studies. They do this by first asking the "learner" to do some addition of fractions examples and then by prescribing from a set of learning activities a remediation programme which they believe will help overcome the "learner's" problem. The users are then able to evaluate the quality of their diagnosis and remediation programme by rediagnosing the "simulated learner".

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by

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1.0 Introduction

Expert teachers have the skills and knowledge to be able to identify learners' weaknesses and provide appropriate remediation. Novice teachers do not have these skills and knowledge. At present, teacher expertise in the area of diagnosis and remediation in mathematics mainly is acquired through two types of teacher education experiences:

(i) diagnosing and remediating a learner with mathematical learning problems; and
(ii) error pattern analysis.

Experience with learners is a haphazard and inefficient method of developing teacher expertise in diagnosis and remediation. It is an ethically suspect method because it exposes learners to the mistakes of novice teachers. It also is difficult for teacher educators to adequately monitor and evaluate. Additionally, it exposes the novice teachers to a very limited range of mathematical learning problems.

The systematic analysis of error patterns taken from students' work also has some serious limitations. The analysis of an error pattern usually proceeds in three phases:

Phase 1 Identify the error pattern
Phase 2 Identify the underlying causes of the error pattern and state possible reasons for the learner's use of the error pattern
Phase 3 Plan a sequence of remediation activities.

Most novice teachers experience few problems with the first phase of the analysis; the identification of the error pattern. They however experience great difficulties with the second and third phases of the analysis; identifying the underlying causes and planning an appropriate sequence of remediation activities. This is not surprizing because these two phases of the analysis require the novice teachers to do more than just recall information which they have acquired from their mathematics education courses. These two phases in fact require the novice teachers to utilize higher level application thinking skills based on accurate observation of students. Because of this, most novice teachers tend to utilize a "shotgun" approach in these two phases and thus produce rather inexact and impractical diagnostic and remediation reports.

$1/3 + 2/3 = 3/6$

$1/4 + 3/4 = 4/8$

$3/5 + 5/8 = 8/13$

Figure 1 An Error Pattern for Addition of Fractions

Because of the limitations discussed above, these two traditional types of experiences are not very effective means of developing high levels of teacher expertise in diagnosis and remediation. Thus, it is not surprizing that research conducted in Australia and overseas has found that most teachers either do not diagnose to obtain a clear view of their students' understandings and misconceptions or limit their attention to the product of their students' work rather than focussing on the processes and strategies employed by their students (Bennett, 1987). The apparent ineffectiveness of these two types of experiences has provided the motivation for the production of PRODIGY, an intelligent computer-based simulation system for developing teachers' expertise in the diagnosis and remediation of common error patterns in the domain of common fractions.

The major aims of PRODIGY are:

(i) to develop diagnostic and remediation expertise in pre-service and postgraduate mathematics teachers;
(ii) to help teachers gain deeper insights into how students learn and mislearn mathematics; and
(iii) to help adult learners (including novice teachers) gain deeper understandings of the mathematics they are learning.

PRODIGY has these two important features which its developers believe help it overcome most of the serious limitations that have plagued the traditional methods of developing teacher expertise in diagnosis and remediation:

(i) it provides a theoretical framework for a detailed study of diagnostic and remedial processes; and

(ii) it allows expertise to be acquired by novice teachers in pre- and in-service courses with the necessary monitoring, evaluation and rapid feedback, without the time-consuming and costly provision of children, and without the need to expose these children to inexpert teaching and evaluation.

In the section that follows, the architecture and the functioning of the PRODIGY in its present form will be described. Following this, a description of how the system is used by teacher education students and adult learners will be presented. In the final section of this paper, future directions for this research and development project will be discussed.

2.0 The System

During the preparation of the system, a number of assumptions based on close classroom observations and laboratory research were made about how students learn and do mathematics and a number of criteria for an effective system were specified. The assumptions made about how student's learn and do mathematics were:

(i) that many of the errors that students make in mathematics are systematic; and

(ii) that the underlying causes of these error patterns are related to the manner in which mathematical knowledge is stored and structured within the student's long term memory.

The criteria for an effective system were:

(i) that the system's actions should parallel the actions of real students as closely as possible;

(ii) that the system should give novice teachers easy access to its knowledge base so that they can better understand the underlying causes of why students develop error patterns in mathematics;

(iii) that the system should have psychological validity; and

(iv) that the domains of knowledge explored by the system should be those in which most students experience difficulties.

One major consequence of these sets of assumptions and criteria has been that the system is based on a network of production systems which focuses on the addition of common fractions. Before proceeding on to a description of the system, it first would be desirable to briefly describe what a production system is and how it operates.

2.1 Production Systems

Production systems were first employed by Newell & Simon (1972) in order to help in the analysis of detailed protocols of human problem solving behaviour. According to Young,

> the technique attempts to capture regularities in a subject's behaviour by writing a set of independent rules--known as **a production system** (PS)-- that expresses what the subject does under what conditions (Newell, 1968; Newell & Simon, 1972). Each individual rule (or PR for `production rule') is a condition-action statement of the form C ===> A, and means simply that in the circumstances specified by C the subject performs action(s) A. (Young, 1971, p3)

The condition side of a production refers to the symbols in the Short Term Memory (STM) that represent the goals and the elements of knowledge existing in the system's momentary knowledge state. The action consists of transformations such as the generation, interruption and satisfaction of goals, modifications of existing elements and the addition of new elements to the STM.

The architecture of a classical production system (Klahr, Langley and Neches, 1987) is presented in Figure 2 below. The STM holds an ordered set of symbolic expressions or chunks. New expressions always enter the STM at the front or left hand end. Thus, when (Temp > 72) enters the STM in Figure 2 below, the contents of the STM will be:

(Temp > 72) (Temp = 71) (Furnace on).

The conditions of the production rules examine the expressions in the STM in order starting from the front. Front expressions in the STM thus may preempt later expressions. The LTM consists entirely of an ordered set of production rules. Each production rule is written with the condition on the left separated from the action(s) on the right by an arrow. In Figure 2, only two production rules are shown: T1 and T2.

This particular production system operates a thermostatic control device whose purpose is to keep the temperature of a room between 70-72 degrees fahrenheit. As the system stands initially, none of the production rules in the LTM is satisfied by the contents of STM and nothing happens. However, as is shown in Figure 2, (Temp > 72) is about to enter the system from the external world. When it does, the contents of the STM will contain the two conditions necessary for the selection and the execution of Rule T2 by the system:

(Temp > 72) and (Furnace on).

The action of Rule T2 will be to turn the furnace off.

In contrast, if the contents of the STM had indicated that the furnace was off and if the incoming information from the external world was:

room temperature less than 70 (Temp < 70),

then Rule T1 would have been executed. Its action would be to turn the furnace on and heat up the room.

TOTAL SYSTEM

LTM

T1 (Temp < 70) (Furnace off) ===> Turn on Furnace

T2 (Temp > 72) (Furnace on) ===> Turn off Furnace.

STM

(Temp = 71) (Furnace on)

Figure 2 Overall Architecture of a Production System

2.2 The Prototype

Although production systems have predominantly been used to analyse adult protocols, production systems have a number of properties which make them most appropriate for the present project of producing a system for the diagnosis and remediation of error patterns associated with the addition of common fractions:

(1) Production Systems can serve as a miniature "Artificial Subject" whose reactions to different experimental manipulations can be empirically explored. The production system thus can be used to predict a learner's cognitive behaviour under certain conditions much more precisely than with most other techniques.

(2) Production Systems analyse problem solving into components which specify not only what a learner does but also when he (or she) does it. Most techniques, such as Gagne's technique of task analysis (Gagne, 1962, 1968) and Pascual-Leone's technique of M-Space analysis, only indicate what the learner does. The solution of a problem, however, involves more than the simple linking together of a list of subtasks. Information about when and how these sub-tasks are linked together is just as important. This capability of production systems to specify what the learner does, when s/he does it and how the learner does it is therefore most useful when one is trying to develop a complete processing model.

(3) The explicit control structure of a Production System makes clear exactly which decisions the learner has control over and which decisions are forced on him (or her) by the environment. Production Systems thus allow one to clearly indicate how the learner's goals affect performance on a task. With many other techniques, this is well nigh impossible especially if one tries to simultaneously indicate how environmental factors may have affected performance.

(4) Production Systems can cope with minor variations to a Task. This enables construction of a single processing system to handle all variations of the addition and subtraction of fractions tasks rather than the construction of separate systems for each variation of the tasks as has to be done with most other techniques such as flow-chart and M-Space analyses (Pascual-Leone, 1970).

(5) Production Systems are the most homogeneous form of programming organization known to man (Newell & Simon, 1972). Each production rule represents a fragment of potential activity that is a meaningful component of the total problem solving process. Individual production rules therefore frequently possess a kind of local plausibility which enables them to be discussed sensibly in isolation. With most other techniques, the parts cannot be isolated out of the system to be discussed and modified; the system has to be discussed and modified in toto.

This structural independence of the production rules has two important consequences. Various sets of production rules can be combined freely to form working production systems. This makes it possible to show how certain production rules or schemas perform critical functions in more-than-one number-related task. Secondly, it is possible to incrementally add new production rules or modify previous rules to extend a production system so that it can handle more complex tasks or the same tasks in a variety of new contexts. This makes it possible to identify consistencies and differences between successful and unsuccessful performances on the complex number tasks very precisely.

The use of production rules in PRODIGY thus has enabled its creators to produce a powerful and flexible system which meets all of the criteria required of the system. As is illustrated in Figure 3 below, the prototype system consists of a network of three interrelated production subsystems: an executive subsystem (called MAINLIST), an equivalent fraction generating subsystem (called EQUIVFRACT), and a lowest common multiple generating subsystem (called LCM).

MAINLIST <------------> EQUIVFRACT <--------> LCM

Figure 3 The Prototype System

MAINLIST affects the overall operation of the system by selecting which of the other subsystems will be operational at any point in time. EQUIVFRACT generates equivalent fractions when asked to do so by MAINLIST; LCM is activated by EQUIVFRACT to generate the lowest common denominators.

For example, if the system is asked to calculate

$$1/2 + 1/3$$

MAINLIST first peruses the problem. When it finds that the two fractions have different denominators, MAINLIST activates EQUIVFRACT. Because EQUIVFRACT has not got any rules which enables it to generate the lowest common denominator, it in turn activates LCM. When LCM has determined that the lowest common denominator is 6, EQUIVFRACT is reactivated. EQUIVFRACT then converts 1/2 to 3/6 and 1/3 to 2/6. MAINLIST is then reactivated. The rules in MAINLIST then generate the answer 5/6.

The power of the system as a means to produce expert teacher diagnoticians however only really becomes apparent if one of the three following modifications are made to the system:

(i) one or two critical production rules are removed from one or more of the subsystems;
(ii) one or more "malrules" (Van Lehn and Brown, 1980) are included in one or more of the subsystems; or
(iii) a combination of the first two types of modifications occur.

This has been done to recreate six "case study learners" who exhibit qualitatively different classes of error patterns when they are asked to add common fractions. These six "case studies" are able to simulate 95 percent of known error patterns in this domain.

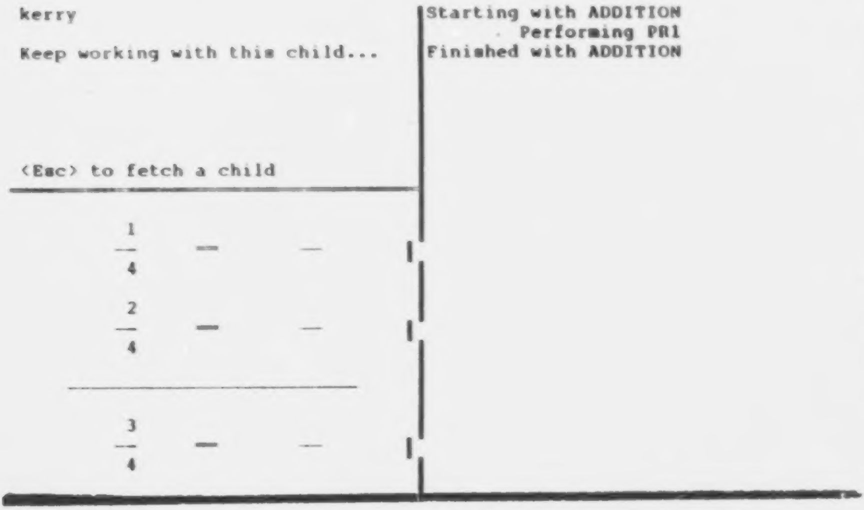
3.0 How the System is used

3.1 With Novice Teachers

In simulation sessions with PRODIGY, the novice teachers are required to carry out the following sequence of activities:

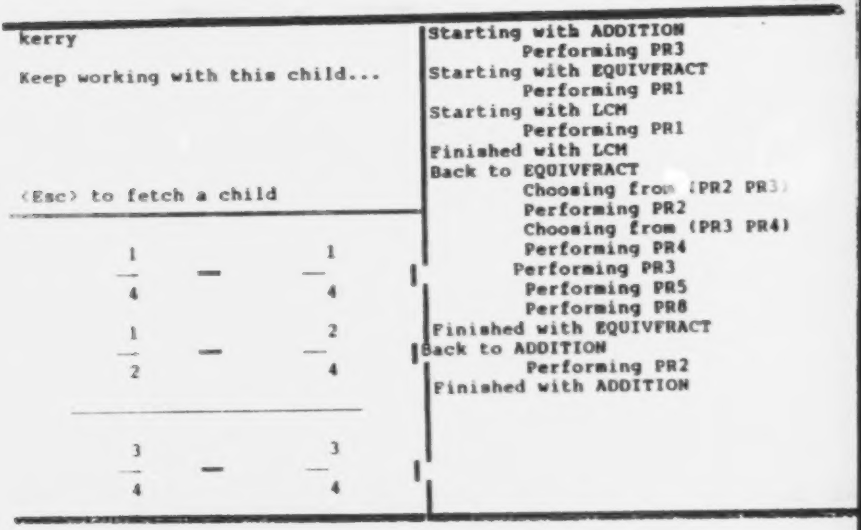
- (i) they administer some addition of fractions examples to the "simulated learner" which they have selected to diagnose and remediate;
- (ii) they observe the procedures used by the "simulated learner" as it adds the common fractions;
- (iii) they hypothesize the underlying causes of the "simulated learner's" error patterns;
- (iii) they evaluate their hypotheses by asking the "simulated learner" follow-up questions; and
- (iv) they suggest what the "learner" would need to be taught to overcome the error pattern.

This sequence can best be illustrated by briefly describing a group of three novice teachers interactions with the system as they diagnosed "Kerry". They began the diagnosis by asking the case study to add 1/4 and 2/4. As is illustrated in Figure 4, "Kerry" was able to generate the correct answer to the problem very quickly and accurately.



```
kerry                               |Starting with ADDITION
                                    |        . Performing PR1
Keep working with this child...     |Finished with ADDITION



<Esc> to fetch a child
------------------------------------

        1
        --     --      --      |
        4

        2
        --     --      --      |
        4
     --------------------
        3
        --     --      --      |
        4
```

Figure 4   Diagnosis of Kerry #1



```
kerry                                  Starting with ADDITION
                                                Performing PR3
Keep working with this child...        Starting with EQUIVFRACT
                                                Performing PR1
                                       Starting with LCM
                                                Performing PR1
                                       Finished with LCM
                                       Back to EQUIVFRACT
<Esc> to fetch a child                          Choosing from (PR2 PR3)
                                                Performing PR2
                                                Choosing from (PR3 PR4)
        1              1                        Performing PR4
        -      —       -                      Performing PR3
        4              4                        Performing PR5
                                                Performing PR8
        1              2                Finished with EQUIVFRACT
        -      —       -               Back to ADDITION
        2              4                        Performing PR2
                                        Finished with ADDITION
     --------------------

        3              3
        -      —       -
        4              4
```

Figure 5   Diagnosis of Kerry #2

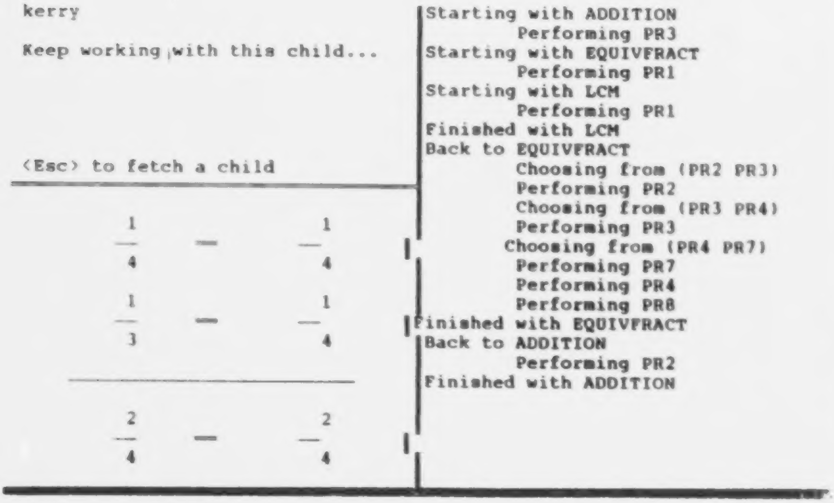
"Kerry" was then asked to compute a more difficult problem: 1/4 + 1/2 (see Figure 5). By observing the lower left-hand window, the novice teachers were able to observe the order in which "Kerry" completed each component of the algorithm. They thus observed that Kerry first worked out that the lowest common dominator was 4, second converted both the fractions to fourths and finally that she added 1/4 to 2/4 to generate the correct answer, 3/4. This seemed to indicate to the novice teachers that "Kerry" clearly understood how to add common fractions with unlike denominators and that she did not have any malrules in her repertoire of knowledge in this domain. This conclusion, however, was an erroneous one. This they discovered six problems later when they asked "Kerry" to add 1/4 and 1/3. As is illustrated in the lower left-hand window of Figure 6, "Kerry" generated an incorrect answer for this problem. The lowest common denominator and the answer which "Kerry" generated for this problem surprized yet fascinated the novice teachers. When pressed by their lecturer, they produced two possible hypotheses to explain how "Kerry" generated the lowest common denominator:

(i) that the larger of the two denominators was chosen as the lowest common denominator; and

(ii) that the first denominator was chosen as the lowest common denominator.

In order to decide which hypothesis was correct, they then administered eight other carefully chosen problems to "Kerry". From their observation of "Kerry's" computations of these eight problems, they were able to ascertain that "Kerry" in fact choose the larger of the two denominators as the lowest common denominator. They were able to confirm their diagnosis by breaking into the system. This was done by looking at the right hand window to discover which production rules "Kerry" used in the computations. By looking up a manual, they then were able to examine each of these rules in detail. In fact, they discovered that "Kerry" had a malrule (PR1) in the LCM list of rules and a malrule (PR7) in the EQUIVFRACT list of rules.

<u>PR1</u> If you have to find the lowest common denominator of two fractions Then choose the larger denominator.
<u>PR7</u> If the denominator of a fraction does not exactly divide into the lowest common denominator Then leave the numerator as is.



```
kerry

Keep working with this child...



<Esc> to fetch a child

        1           1
        —     —     —
        4           4

        1           1
        —     —     —
        3           4
     ___________________

        2           2
        —     —     —
        4           4
```

```
Starting with ADDITION
        Performing PR3
Starting with EQUIVFRACT
        Performing PR1
Starting with LCM
        Performing PR1
Finished with LCM
Back to EQUIVFRACT
        Choosing from (PR2 PR3)
        Performing PR2
        Choosing from (PR3 PR4)
        Performing PR3
       Choosing from (PR4 PR7)
        Performing PR7
        Performing PR4
        Performing PR8
Finished with EQUIVFRACT
Back to ADDITION
        Performing PR2
Finished with ADDITION
```

<u>Figure</u> 6   Diagnosis of Kerry #3

Following the completion of the diagnosis phase of the activity, the novice teachers produced a remediation programme for "Kerry".

3.1 With Adult Learners

Although PRODIGY was originally designed to facilitate the development of high level diagnostic and remediation skills in teachers, the system has been found to be a very effective tool to help adult learners gain deeper understandings of common fractions concepts and processes after they have had initial instruction and some consolidation in this domain. By exploring the processes by which error patterns are generated, the adult learners seem to be able to better understand why the correct rules and algorithms work. The adult learners also have indicated that their explorations with PRODIGY error patterns helps them to generate better questions to ask their instructors in workshops.

4.0 Future Directions

Novice teachers and adult learners seem to find PRODIGY simulations non-threatening and enjoyable. Initial experiences with PRODIGY also seem to indicate that it is a very effective tool for developing the diagnostic skills of novice teachers. In particular, we have noted that the quality of the novice teachers selection of diagnostic test items rapidly improves after interactions with only one or two of the case studies simulated in PRODIGY. Another particularly pleasing observation has been that novice teachers who have explored PRODIGY simulations seem to be better able to synthesize theory with practice and knowledge from educational psychology and curriculum studies subjects with mathematics education knowledge. Many have volunteered that after they had "played with PRODIGY", they have for the first time really understood what some of the research papers from the mathematics education and educational psychology courses "had been on about". For example, two novice teachers commented that until they had done PRODIGY simulations, they could not see the relevance for teaching of research on chunking and Short Term Memory Capacity. But perhaps the most pleasing outcome of the novice teachers' interactions with PRODIGY has been a growing awareness in them that incorrect understandings and processes can produce correct answers and therefore that it is imperative for teachers to actively investigate how learners generate their answers.

The present system, however, has these limitations which need to be overcome if the overall aims of the research project are to be achieved:

(i) it only enables teachers to satisfactorily simulate diagnostic skills; and
(ii) it only models computational/procedural knowledge.

Teachers using PRODIGY thus have tended to focus exclusively on the procedural knowledge and overlook the roles of the conceptual knowledge in the learning of mathematics.

For the ultimate aim of the research program to be achieved, these two limitations will need to be overcome. Three critical tasks in the development of the simulation system which therefore need to be completed in the future are:

(1) the production of a model for representing both the computational/procedural and the conceptual knowledge that underlies the error patterns;
(2) the modelling of the conceptual knowledge embedded in remediation lessons; and
(3) the integration of these models into a user-friendly diagnosis and remediation simulation shell.

These knowledge representation models will form the core of the improved simulation system. Once embedded within the simulation system, they will enable teachers to explore and diagnose deficiencies and/or malrules within the repertoires of conceptual and procedural knowledge of the case studies. They also will enable the system to simulate the effects of "teaching" specific types of lessons to learners manifesting addition of fractions error patterns.

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The author would like to acknowledge Chris Martin's collaboration in the development of PRODIGY. Chris developed the muLisp production system shell for PRODIGY.

TEACHING AID FOR COMPUTER ARCHITECTURE AND LOW-LEVEL PROGRAMMING

by

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ABSTRACT

The Higher National Diploma (HND) in Computer Studies is one of the courses offered by the Centre for Computer Studies. The course, which emphasises on information systems, is accredited by the Business and Technician Education Council (BTEC) in United Kingdom as well as the British Computer Society (BCS). The BCS has also granted exemption to those who successfully completed the course from Part I of their examinations.

A unit taught in the course is Computer Architecture which aims to provide students with the principles and fundamental concepts of modern computer architecture.

This paper describes a PC-based graphical simulation package that has been developed to assist in the teaching of these concepts as well as assembly language programming. Generally, the teaching aid provides a 'gentler' approach to assembly language programming by concentrating on essential subset of instructions of a typical microprocessor. It also allows students to graphically trace through the micro-instructions and micro-operations of the fetch-execute cycle of each instruction while it is being executed by the central processing unit(CPU). The paper will also highlight the feedback from the students based on a survey conducted and the plan for enhancement.

1. INTRODUCTION

The Centre for Computer Studies (CCS) is one of the key institutes in Singapore which provide an education for information technology (IT) professionals. The Centre was established in 1982 at the Ngee Ann Polytechnic, and has since developed into a centre of excellence for practice-orientated IT education in Singapore.

The Centre offers three main courses, namely Higher National Diploma (HND) in Computer Studies, Advanced Diploma in Information Systems and Software Engineering (ISSE) and Advanced Diploma in Data Communications and Networking (DCN). The two Advanced Diploma courses provide the opportunities for HND graduates and graduates with equivalent qualification to upgrade themselves.

The HND course involves two years of full time study, and comprises the following course units in the first year :

- Communication for Information Systems Professional (CISP)
- Computer Architecture (CA)
- Organisational Information System (OIS)
- Program Design & Implementation (PDI)

and the following units in the second year :

- Computer Systems and Networking (CSN)
- System Analysis and Design (SAD)
- Software Systems Development (SSD)
- Database Management Systems (DMS)
- Systems Development Management (SDM)
- Individual Project

The main thrust of the HND course is to provide entry-level, general computer education oriented towards information system development. The minimum admission requirements consist of GCE passes in five subjects including two at Advanced Level. Other than a minimum of Ordinary level passes in Mathematics and English Language, there are no pre-requisite required in subjects such as Physics and Mathematics at Advanced Level and specifically no computer knowledge is assumed. The Centre targets an intake of 270 annually.

2. COMPUTER ARCHITECTURE UNIT

This unit, taught in the first year, introduces students to the operational principles of modern computer. It looks at the functional capabilities of a computer, the role of system software and how various hardware units of the computer system are organised and set up to run user programs. Generally, the topics taught within this unit include :

- Computer System Fundamentals
- Computer Peripherals
- Number Systems
- Logic Gates and Boolean Algebra
- System Software and Operating Systems
- CPU Architecture & Fetch and Execute Cycle
- Microprogrammed Control Unit
- Assembly Language Programming
- I/O Organisation
- Basic Concepts of Data Communications

Teaching an introductory course on the internal architecture of a typical CPU and assembly language programming involves description of all its components and their interconnections, typical instruction set and assembly language programming. Students who encounter computer studies for the first time often find this topic rather difficult. This is especially true for most of the CCS students who have taken commerce or arts subjects at GCE Advanced Level and who have little or no knowledge of computer hardware. As such, they frequently encounter difficulties in relating the theoretical knowledge on computer architecture to actual computer organisation and programming in assembly language. To ensure students appreciate the fundamental concepts of computer architecture like fetch-execute cycle, micro-instructions, micro-operations and micro-programmed control unit can be a difficult task. The limited time allocated to teaching assembly programming, which is used as a vehicle to illustrate the hardware-software interaction, has also added to the difficulties. Students very often find it difficult to start coding in assembly language and also fail to appreciate the usage and operations of different assembly instructions.

To overcome some of these problems, a PC-based graphical simulation package, known as 'A Paper Computer' (APC), has been developed as a teaching aid to provide fundamental ideas on computer architecture and exercises on writing and debugging simple assembly language programs. The package has undergone several revisions and the latest version is called APC II, the features of which are discussed in the following sections.

The main objectives of this package are as follows:

- To enable students to visualise the internal operation of the various components of a typical computer through the use of graphical technique;
- To provide students with a user-friendly environment to develop assembly programs;
- To enable students to see what is happening when an assembly program is executed by the CPU and its correlation with the source program;
- To appreciate the fundamental concepts of fetch-execute cycle and its micro-instructions and micro-operations.

3. EVOLUTION OF APC

The introduction of APC started off as a 'sticker and cardboard' approach (which explains why this hypothetical machine was known as 'A Paper Computer'). This paper computer was used during tutorials for manual manipulation and demonstration. Students were asked to manipulate the appropriate stickers, symbolising the various components of the CPU and their contents, to emulate the execution of instructions.

This was subsequently implemented on the microcomputers, first on the ICL PCs running under MP/M & CCP/M operating systems[4] and later on the IBM PC compatibles (ALR DARTs & ALR PowerFlex Plus) under MS-DOS.[5,6]

The general architecture of the APC machine is basically an accumulator-based computer as shown in Figure 1.

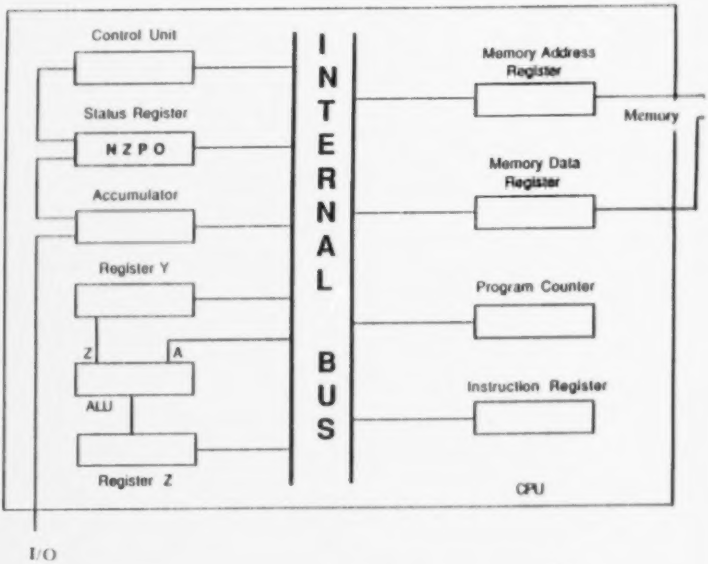

Control Unit
Status Register
N Z P O
Accumulator
Register Y
Z
A
ALU
Register Z
INTERNAL BUS
Memory Address Register
Memory
Memory Data Register
Program Counter
Instruction Register
CPU
I/O

FIGURE 1 : ARCHITECTURE OF THE APC MACHINE

4. FORMAT OF APC INSTRUCTIONS

APC II has 15 single-address machine instructions whose format is shown in Figure 2. These instructions include arithmetic operations like addition, subtraction, multiplication, division, increment & decrement; data transfer operations such as load, store, input & output; jump operations; and halt operation (see appendix 1).

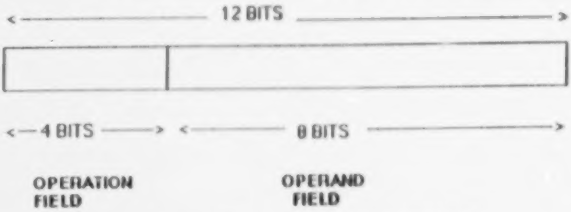
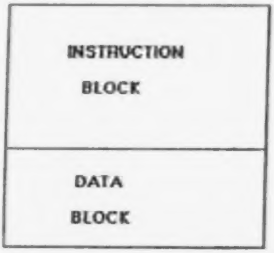

12 BITS
4 BITS
8 BITS
OPERATION FIELD
OPERAND FIELD

FIGURE 2 : APC II INSTRUCTION FORMAT

The word length of the instruction is 12 bits with 4-bit operation field and 8-bit operand field. The data format is of 8-bit integer and 4-bit fraction in two's complement. Such an unusual format has been adopted mainly as a compromise between the need to allow students to explore fractional representation of numbers and precision in calculation on the one hand and the need to keep the computer design simple on the other.

A typical APC program consists of two blocks :



The format of each APC instruction within the instruction block is as follows :

```
LABEL :  OPERATION   OPERAND        * COMMENTS
```

For the data block, each data declaration is formed by 2 parts :

a) the name of the data
b) the value of the data (if pre-defined)

The following is an example of an APC program which reads n numbers and calculates and outputs the average :

```
         INPUT
         STORE NUMBER      * n numbers to be input
LOOP   : STORE COUNT
         INPUT             * input numbers
         ADD TOTAL
         STORE TOTAL
         LOAD COUNT
         DEC
         JPOS LOOP
         LOAD TOTAL
         DIVIDE NUMBER     * calculate the average
         OUTPUT
         HALT

COUNT  :            * holds the count of numbers yet to be read
NUMBER :            * holds n
TOTAL  :            * holds the cumulative sum of number read
```

5. FUNCTIONS OF APC SOFTWARE

The APC software essentially consists of three major modules :

a) ASSEMBLER - Its main function is to perform a syntax check and diagnosis of the source program. It also translates APC assembly program to 'machine code' and stores it in a code file. It will display error messages whenever necessary.

b) EXECUTER - Its main function is to execute the code file generated by the assembler. During the execution, the instruction to be executed is displayed as well as the contents of the program counter(PC) and the accumulator.

The main purpose of this module is to allow the user to check if a program produces expected results without checking through individual instructions. It also checks the status of the accumulator and allows user to restart the execution if overflow is detected.

c) TRACER Similar to the Executer, its main function is to execute the code file generated by the assembler. The main purpose of this module is to allow users to check the working of a program step by step and to debug the program.

With the Tracer, user can also switch to another display that shows the detailed micro-instructions in a fetch-execute cycle for each machine instruction of the APC program.

Upon invoking the APC software, user will receive a welcome screen and the main menu. User may choose any of the five options provided, namely APC Assembler, APC Tracer, APC Executer, Wordstar Editor or Exit. The software is implemented to interface with Wordstar version 5.5, which is used as an editor for user to create and edit APC programs. The Wordstar package will be invoked when the option 'Wordstar Editor' is chosen. An APC program must be created in a Nondocument file.

Once the APC program has been created, user must choose the 'APC Assembler' option to assemble the program. The APC program is assembled through a 3-pass process i.e.

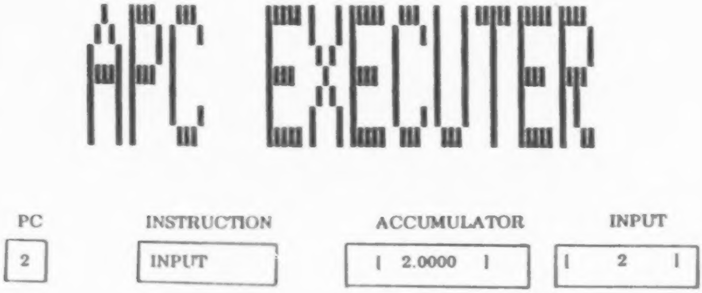
Pass 1 checks for syntax errors
Pass 2 checks for consistency between the reference in the operand
    field of an instruction, and a label of an instruction or
    store location
Pass 3 generates an object file.

If the program has any syntax errors, appropriate error messages will be displayed and the assembly process will terminate.

If an instruction in the APC program refers to a label or data location that is not declared, the Assembler will detect it in pass 2. Again if error is detected, then pass 3 will not start and the assembly process will terminate.

After having successfully assembled the program, the user has an option to execute the program using the 'APC Executer' or 'APC Tracer'.

Once started, the APC Executer will step through the program instructions automatically at a speed that can be selected by the user, until the program halts or input is required. A snapshot of this execution process is shown in figure 3 below which presents the content of Accumulator after executing the instruction located at word 2.



APC EXECUTER

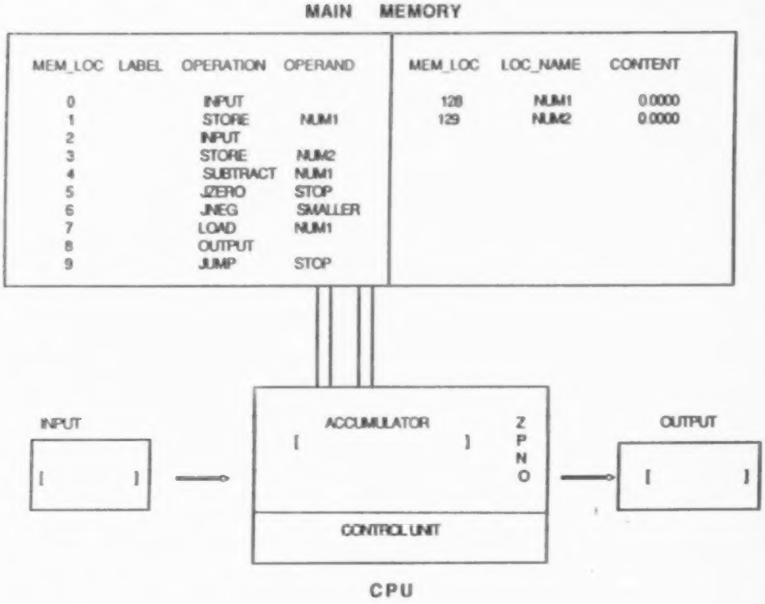
PC	INSTRUCTION	ACCUMULATOR	INPUT
2	INPUT	| 2.0000 |	| 2 |

FIGURE 3 : APC EXECUTER

The APC Tracer, on the other hand, allows the user to control via the keyboard the execution of the program. During execution, a maximum of 10 instruction lines will be displayed. User can trace through the program one instruction at a time.

The data flow from one component to another component of the APC machine as the result of executing an instruction will be graphically shown as the user traces through the program (see figure 4).

User can toggle between displaying in assembly code and machine code. In assembly code, user can concentrate on understanding the operation of various components with the instructions and data being displayed in mnemonics and decimal respectively. In machine code, user can examine how instructions and data are actually stored or processed in binary format.



MEM_LOC	LABEL	OPERATION	OPERAND
0		INPUT	
1		STORE	NUM1
2		INPUT	
3		STORE	NUM2
4		SUBTRACT	NUM1
5		JZERO	STOP
6		JNEG	SMALLER
7		LOAD	NUM1
8		OUTPUT	
9		JUMP	STOP

MEM_LOC	LOC_NAME	CONTENT
128	NUM1	0.0000
129	NUM2	0.0000

FIGURE 4 : APC TRACER

The user while tracing through the program under APC Tracer may select another option to display the detailed micro-instructions in a fetch-execute cycle for each instruction.

This option essentially shows the corresponding micro-operations performed by the components of an APC II computer, i.e registers, ALU and main memory, for each of the micro-instructions, as shown in Figure 5. The main purpose of this option is to allow users to step through the micro-instructions of each APC machine instruction and see its micro-operations performed graphically.

User can also toggle between displaying in assembly code and machine code.

With this extension the tedious process of manually tracing through the contents of the CPU registers, carried out during a tutorial supporting fetch & execute cycle, can be turned into a PC-based practical.

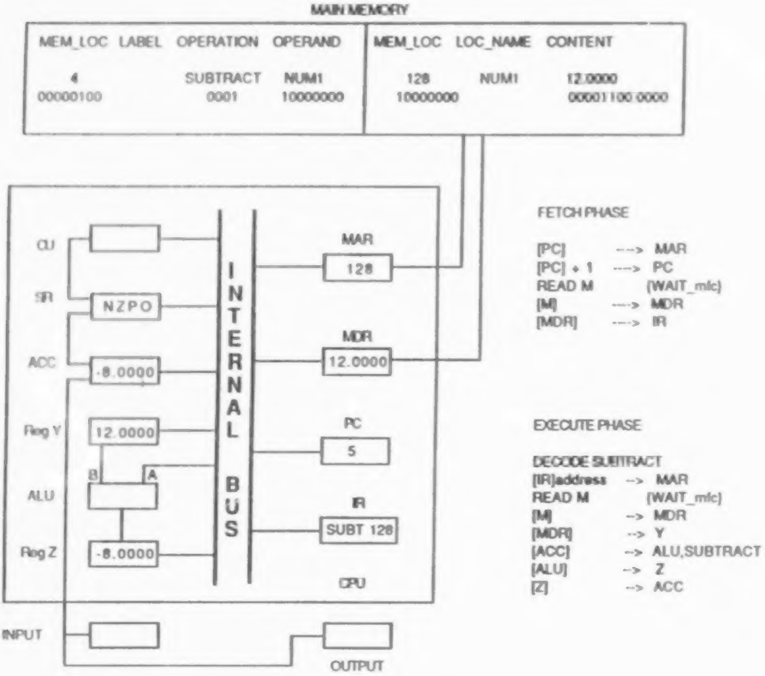

MAIN MEMORY
MEM_LOC LABEL OPERATION OPERAND
4 SUBTRACT NUM1
00000100 0001 10000000
MEM_LOC LOC_NAME CONTENT
128 NUM1 12.0000
10000000 00001100.0000
CU
SR
NZPO
ACC
-8.0000
Reg Y
12.0000
B
A
ALU
Reg Z
-8.0000
INTERNAL BUS
MAR
128
MDR
12.0000
PC
5
IR
SUBT 128
CPU
INPUT
OUTPUT
FETCH PHASE
[PC] ---> MAR
[PC] + 1 ---> PC
READ M (WAIT_mfc)
[M] ---> MDR
[MDR] ---> IR
EXECUTE PHASE
DECODE SUBTRACT
[IR]address --> MAR
READ M (WAIT_mfc)
[M] --> MDR
[MDR] --> Y
[ACC] --> ALU,SUBTRACT
[ALU] --> Z
[Z] --> ACC

FIGURE 5 : FETCH/EXECUTE CYCLE OF THE APC MACHINE

6. FIELD EXPERIENCE AND EVALUATION

The APC software in various versions has been used to support the teaching of Computer Architecture unit since 1987.

A survey was recently conducted to seek feedback from the 1990/1991 batch of HND Year 1 students. Generally, the feedback from the students was favourable and the APC software was considered to have achieved its objectives. More than 80% of the students believed that the software has fulfilled its set objectives [Table A in Appendix 2]. Though some of the students felt that the user-interface and user-friendliness can be improved, the majority has indicated that it is adequate [Table B in Appendix 2]. The software has adequately helped students in their understanding of the related concepts taught in the course [Table C in Appendix 2].

From the feedback, some students indicated that the APC language is too simple and has limitations in the number of instructions as well as their functionality as compared to a real assembly language like Microsoft MacroAssembler (MASM). As such, they felt that it does not truly present a complete picture of assembly language programming which was taught later in the course.

The consensus among the teaching staff has been positive. In particular, the Computer Architecture teaching team has decided to retain the use of APC II in a major course review recently, despite the fact that there is potential confusion between APC II assembly language and the 80x86 assembly language that students need to study and use in the later part of Computer Architecture unit. The reasons are four fold:

(1) APC II allows a student, on his or her first encounter with low-level programming, to concentrate on the essential features of assembly language programming, without being bogged down by the details and idiosyncrasies of a real computer and assembly language such as segmentation in 80x86 microprocessor, and by the over-richness in instruction set of a typical microprocessor with CISC architecture.

This simplified and gentler introduction to low-level programming is definitely less traumatic for the students than a direct encounter with 80x86 assembly programming, especially if one considers the fact that the students at that stage would have just completed learning the rudiments of C language programming and have just started on Cobol in the Program Design & Implementation unit that runs in parallel with Computer Architecture.

(2) APC II allows students to examine the organization of a simple computer at the lower levels, again focusing on the essential components and the fundamental principles such as fetch-execute cycle without being bogged down by details. It also allows the teaching staff to attempt to present a simplified version of "multi-level machines" propounded by Andrew Tanenbaum [7].

(3) APC II is an effective aid to teaching a large group of students. It allows each student to 'control' the operation of a computer, for example the fetch-execute cycle by using the Tracer module, and understand its working at his or her own pace. This can be repeated easily either in supervised practical periods or during unsupervised workshop periods.

(4) APC II provides a chance to emphasize the fundamental principles that are common to many modern computers. For example, the main features of a von Neumann computer can be identified in APC II as well as in the 80x86 microprocessors that students study later on.

7. FUTURE DEVELOPMENT

With the current implementation of APC II, the package essentially covers the middle three levels of Tanenbaum's six-level model, namely

Level 4	Assembly Language Level
Level 2	Conventional Machine Level
Level 1	Microprogramming Level

while Level 3, the 'hybrid' Operating System Machine Level is omitted because of its complexity.

Level 1 Microprogramming Level has been presented in a functional way in APC II package: students are shown 'what' operations are carried out by the micro-instructions that make up a machine instruction. It is envisaged that this machine level could be made complete by extending the package to show 'how' a microprogrammed control unit can make use of a set of microprograms to control the operations of the computer components. This extension has been set as a 8-week HND final year project that is currently in progress.

This latest enhancement would probably be the limit to which we could and intend to extend the APC II, since Level 0 Digital Logic Level and Level 5 Problem-Oriented Language Level would entail a level of complexity that is beyond the scope of Computer Architecture unit.

However, there are still areas where APC II could be further developed:

(1) As it is, APC II does not provide facilities that one would normally associate with a full-fledged CAI package, such as quiz and test to gauge user's understanding and perhaps make personalized suggestion on what user should do next.

(2) APC II package has been implemented using Turbo Pascal. While it is a useful tool to exercise the skills and ingenuity of HND final year students who have carried out the implementation and extention in the last few years, it falls short in terms of support required of CAI authorware, especially in ease of maintenance. It would be advantageous to identify a CAI authorware to re-implement parts of APC II which make extensive use of graphical presentation and to enhance APC II to provide more comprehensive CAI facilities.

In addition, the teaching staff at the CCS could make more innovative use of APC II, for example, by devising more difficult problems for students to solve in APC II. This may be done with the intention to help them recognize the limitations of APC II, as some of the students had discovered and commented in their feedback in the recent survey. This could provide the motivation for students to learn a full-fledged assembly language in which more functional instructions are available. It could also provide a scenario for students to design additional machine instructions to add to APC II instruction set as a paper-and-pencil exercise; this could cover both the functional specification for each of the instructions as well as its implementation in micro-instructions.

8. CONCLUSION

Teaching a 'technical' subject such as Computer Architecture to students with 'non-technical' and varied background has been a challenging and at times frustrating task at the CCS. With the use of APC II, a PC-based graphical simulation package, such a task has been made considerably easier. While the students as well as the teaching staff at the CCS are in general favourably disposed towards the use of the current version of the package in learning and teaching CPU organization and operation and low-level language programming, there remain other possibilities in exploiting its potential.

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APPENDIX 1

APC II INSTRUCTION SET

MACH CODE	OPERATION	FUNCTION
0000	ADD	Add the content of a memory location to that of the accumulator and put the result in the accumulator.
0001	SUBTRACT	Subtract the content of a memory location from the accumulator and put result in the accumulator.
0010	MULTIPLY	Multiply the content of the accumulator to that of a memory location and put the result in the accumulator.
0011	DIVIDE	Divide the content of the accumulator by that of a memory location and put the result in the accumulator.
0100	LOAD	Copy into the accumulator the content of a memory location.
0101	STORE	Copy the content of the accumulator into a memory location.
0110	INPUT	Input the next data from the input device to the accumulator.
0111	OUTPUT	Output the content of the accumulator to the output device.
1000	HALT	Terminate the program execution.
1001	JUMP	Jump, unconditionally, to the instruction in the memory location specified in the operand field.
1010	JZERO	Jump if the accumulator is zero.
1011	JNEG	Jump if the accumulator is negative.
1100	JPOS	Jump if the accumulator is positive.
1101	INC	Add one to the content of the accumulator.
1110	DEC	Subtract one from the content of the accumulator.

APPENDIX 2 - SURVEY RESULTS

TABLE A - ACHIEVING ITS OBJECTIVES

OBJECTIVES	%YES	%PARTIALLY
1. To enable students to visualise the internal operation of the various components of a typical computer through the use of graphical technique;	87	13
2. To provide students with a user-friendly environment to develop assembly programs;	84	16
3. To enable students to see what is happening when an assembly program is executed by the CPU and its correlation with the source program;	84	16
4. To appreciate the fundamental concepts of fetch-execute cycle and its micro-instructions and micro-operations.	82	18

TABLE B - MODULES EASY TO USE AND UNDERSTAND

MODULE	%COMPLETELY	%PARTIALLY
1. ASSEMBLER	79	21
2. EXECUTER	82	18
3(A) TRACER	80	20
(B) FETCH-EXECUTE CYCLE	74	26

TABLE C - AID IN THE UNDERSTANDING OF THE VARIOUS CONCEPTS

CONCEPTS	%COMPLETELY	%PARTIALLY
1. The internal architecture of a typical computer	66	34
2. Machine Language	56	44
3. Assembly Language Programming	57	43
4. Fetch-Execute Cycle	74	26
5. Micro-Instruction & Micro-Operation	60	40

ARE WE TRAPPED BY OUR TRAINING?

by

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Abstract

Nearly twenty years ago Gerry Weinberg reported that he could predict a trainee PL/1 programmer's prior computing background from the way he used his new language and this can be considered as as an instance of the Sapir-Whorf theory which suggests that ours languages shape the way we think. Recently Richard Pettersen has suggested a relation between the computer languages Pascal, Prolog and Basic and the mother tongues of their creators.

This psychological effect is relevant to the long term impact of industrial training in the information technology field. This is because the majority of the training effort goes into teaching how to use very specific languages, systems and packages, which often have short lifespans compared with the average employee's working life. The continued use of tarted up version of first generation high level languages such as COBOL and Fortran would seem to owe much to the large pool of programmers for whom is is easier to continue with the old, rather than switch to newer, more sophisticated tools.

But how important is the effect in practice? One effect will be that information technology employers will show an increased preference for the young - who can be trained without having to counter-act the mental clutter the old have accumulated by working with what are now obsolete systems. Another hazard is more subtle - in that certain ideas will be propagated through the industry for no better reason than, like the QWERTY keyboard, they are accepted by the majority.

This paper examines this last idea in the light of an unconventional educational package called MicroCODIL, which was developed to to demonstrate a wide range of information technology ideas, including some in the artificial intelligence and expert systems areas. The package was well received by the technical press in the U.K. - but problems in getting it widely used were encountered because it was too flexible - and hence violated some of the sacred cows that anyone who works in the computer industry takes for granted. Particular problems are described, and it is concluded that there are information technology concepts in which there are serious mental blocks in the minds of those instructed in procedural programming or relational data base techniques.

Language affects thought

As Benjamin Whorf showed [Whorf, 1956], in his study of American Indian languages, the structure of the languages we use has a major effect on the way we think. Our assumptions about space, time, and form are related to the structure and the lexicon of the natural language we use.

This effect extends to computer programmers. Nearly 20 years ago Gerry Weinberg [Weinberg, 1972] reported that he could predict trainee PL/1 programmers' prior computing background from the way they used the new language. Not only did they tend to use a subset of PL/1 that corresponded most closely to their previous language, but also they tended to assume that the old language restrictions applied to PL/1. The effect is often considered to be very far reaching and Edsger Dijkstra [Dijkstra, 1982] has claimed that:

> "The use of COBOL cripples the mind: its teaching, therefore, should be regarded as a criminal offence"

and

> "It is practically impossible to teach good programming to students that have had a prior exposure to BASIC: as potential programmers they are mentally mutilated beyond hope of regeneration."

While anyone who has ever taught programming can think of cases where such problems occur, Dijkstra has undoubtedly overstated the problem. Of course there are COBOL programmers who are motivated by the problems of commercial data processing who would be left unmoved by Dijkstra's attempts to teach them a "more academic" approach to computer programming. At the time there are theoretically oriented programmers, who revel in the delights of languages like LISP, and who would be equally "crippled" if transferred to the "alien" commercial data processing environment involving messy real world data.

The importance of the mental aspect of programming is highlighted by recent research, such as that by Stone, Jordan and Wright [Stone, 1990]. They studied the impact of PASCAL education on programming skills and concluded that the most relevant area to study was the structure of the programmers' mental processes and representations. Mental models are equally important in the way users at all levels interact with computer packages, and for maximum effectiveness it is important that the language/systems designer, the user, and the educationalist understand the nature and limitations of such models.

Where does Education and Training come in?

These psychological effects are relevant to the long term impact of training in the information technology field. The key question is how far the system designer (at all levels from programming languages to everyday application packages) should be trained to adjust his mental model to suit the user - and how far should he simply be taught to accept the tools he is given. A recent supplement to an Australian computing newspaper [Computing, 1990] contains a summary listing of over a thousand courses. The vast majority were specifically oriented towards specific languages or packages but there was a solitary "User Role in Developing Systems" course put on by the Australian Computer Society. This fits in with an earlier survey of U.K. contracting jobs [Reynolds, 1989] which found only one, out of three thousand jobs listed, directly related to some aspect human-computer interaction. Of course, some of the courses under titles such as "systems analysis" will have some user oriented content but their number is small. Look in any bookshop, and 95% of the computer books will be "how to use it" recipe books, with very few covering the user aspects of design or psychological modelling.

The problem is that the computer industry, of which the computer training and education field is merely a part, has become caught up in a classical technology trap. This occurs because the mental and physical investment in older ideas means that it is easier to train new staff in the old ways that to retrain the more numerous existing staff in new ways. The best known example of such trapping is the sub-optimal QWERTY keyboard, where a century old layout has become an international standard for computers for no better reason that it was already well known. The layout is so deeply ingrained in users' subconscious minds that the only way it will ever be changed is to replace keyboards with other kinds of input device, such as speech recognition. A related development in the word processor field is the awkward and often irrational combinations of control key commands, used in packages such as Wordstar, which date from early keyboards without function key facilities. The MS-DOS operating system for personal computers is rapidly becoming the modern equivalent of the QWERTY keyboard - with its archaic and unfriendly features - but it may not survive for as long in its crudest incarnations because of the advent of WIMP systems which may well replace it with a radically approach to control. The continued use of first generation languages such as COBOL and Fortran would seem to owe much to the large pool of programmers and programs for which it is easier to continue with the old, rather than switch to newer, more sophisticated tools.

In practice what happens is that staff are trained to use languages and packages whose lifetime is short compared with the normal employment lifetime. However once an organisation decides to standardise on a language or package its investment in programs, data, and people is such that it is likely to stay with that language or package until technical advances in the computer field make it obsolete. The consequence is that many staff are faced with five or ten years working with a single system until it is second nature to them, and are then faced with a retraining step which will represent a radical advance in the technology. While it is clear that many people can make such a transition, it is clear that some find it traumatic, while others are unable to make the most of the changes because of many years preconditioning on earlier and now outdated technologies. It is clear from the blatant age discrimination that is widespread in the computer industry that most employers believe that it is better to recruit young staff, who have never been exposed to the old technology, than to retrain old staff with skills to unlearn.

This immediately raises the distinction between training for a particular narrow technology, and education for the future. It is clear that the vast majority of training materials in the computer field contain little or nothing to prepare the students for the changes to come. For example, a few years ago the author carried out a survey of some twenty introductory and advanced COBOL text books in order to select one suitable for teaching. Virtually all of them failed to mention any other computer language, or to identify the general computing concepts which are applicable to any procedural language. While they clearly identified COBOL's strong points, areas in which COBOL is weak compared with other languages were invariably ignored, apparently on the assumption that drawing attention to such difficulties would sully the "COBOL is the solution to all your problems" tone of the overall text. My own experience of long-term COBOL programmers suggests that those who have swallowed this "textbook" line are likely to be the least flexible when things change, and it may well be that Dijkstra's criticism of COBOL should really be directed at COBOL training, and the lack of exposure many COBOL programmers in industry have had to general programming principles.

Context affects Language Development

There is another dimension to the problem. Of course, programming languages influence the way programmers think about problems. Different languages reflect different needs, such as high run time efficiency, logical consistency, ease of use, etc. In addition, each programming language reflects the context in which it was developed and the though processes of its inventors. For example, Richard Pettersen [Pettersen, 1990] recently commented that computer languages often reflect the language and culture of their originators. Thus PASCAL was created by Niklaus Wirth, a German-speaking Swiss and PROLOG clearly reflects its French origins. BASIC is clearly a quickie do-it-yourself tool in the American tradition while COBOL clearly reflects its relation to the world of corporate business.

In a completely different context, Margaret Shotton [Shotton, 1989] surveyed the behaviour of computer addicts, and gained the impression that addicts were good at writing programs that would be highly attractive to other addicts. On the other hand their programs were often unusable by non-addicts because they showed very little understanding of the needed of naive computer users. In fact the situation is almost certainly much more general in that there is a natural tendency for systems designers to design systems which reflect their own mental model of the world. In cases were the user shares a mental model with the designer, this is perfectly satisfactory. In cases of incompatibility, the user will either need to mentally adjust in order to understand the designer's thoughts - or even worse uses the system mechanically and without understanding.

This raises an interesting question. If users fingers are trapped by the ancient QWERTY keyboard, and old-fashioned languages like COBOL and BASIC, or operating systems like UNIX or MS-DOS, can exert such an influence out of inertia, are we in danger of being trapped at a still higher conceptual level? I suspect that we are, and I will give some examples from my own experience in developing a package called MicroCODIL.

The MicroCODIL Experience

A full description of MicroCODIL is inappropriate here, as extensive details have been published elsewhere. However, it is a teaching package designed to allow a wide range of modern information technology research ideas to be introduced to pupils in the classroom in practical teaching situations (Reynolds, 1990a). Within a simple expert system/knowledge base environment it allows topics such as poorly structured information (missing and multivalued data), approximate, range and fuzzy matching and probabilities to be handled in a practical buy non-mathematical environment (for examples of how it is used in teaching see Reynolds, 1988). Human factors have played an important part in the package's design (Reynolds, 1987a, b). It has been been well received by the UK technical and educational press, and used for a wide variety of classroom subjects - including its use for local history studies, where its flexible approach allows the messy data common to historical records to be processed with minimum fuss (Reynolds, 1990b). The MicroCODIL architecture has also been described in detail (Reynolds, 1990c).

As suggested earlier, computer languages reflect the mental model of their creators, and MicroCODIL is no exception. The bsckground context involved considerable experience of manual research and development reporting to the management of an international company, coupled with a design study for a very large and complex computerised invoicing system and virtually no contact with typical "simple" commercial data processing tasks. In such circumstances it is perhaps not surprising that an important element in the underlying model was that real world data is naturally messy and what was required was a dynamically open-ended system which can accommodate the initial ignorance of both the designer and the user as appropriate. The role of ignorance in the design of MicroCODIL, and its relevance to artificial intelligence research, have been discussed at length elsewhere (Reynolds, 1990d) and this paper will confine itself to the way in which MicroCODIL represents data and handles "rules".

The MicroCODIL approach to handling data is best introduced with an example. The following "listing" contains a simplified extract from a typical family history file, describing the incidents in the life of one George Washington Gibbs.

```
1 NAME = Gibbs, George Washington,
2   YEAR = 1802,
3     PLACE = Aylesbury, Bucks,
4       EVENT = Birth,
5         FATHER = Gibbs, Robert,
6           MOTHER = Miller, Ann.
2   YEAR = 1824,
3     PLACE = St Albans, Herts,
4       ADDRESS = Clock House,
5         LANDLORD = St Albans Corporation.
2   YEAR = 1825,
3     PLACE = Watford, Herts,
4       EVENT = Marriage,
5         WIFE = Dagley, Ann.
2   PLACE = St Albans, Herts,
3     YEAR = 1826,
4       ADDRESS = Clock House,
5         OCCUPATION = Printer,
6           OCCUPATION = Broker,
7             OCCUPATION = Pawnbroker,
8               SOURCE = Antique print.
5         OCCUPATION = Auctioneer,
6           PARTNER = Gibbs, John,
7             SOURCE = Trade directory.
3     YEAR >= 1828,
4       YEAR =< 1829,
5         DAUGHTER = Gibbs, Ann.
```

For anyone interested in the history, the file is immediately recognisable, and usable, as a source of information about G W Gibbs. It contains a number of items (each approximately equivalent to a conventional data field) and a number of statements, each describing an event in his life (each approximately equivalent to a conventional record). Any "record" may contain any combination of "fields" and there is no need for any "record" predefinition. (If all the "records" on a file contain equivalent fields, which is perfectly possible, this is because the application requires such a regular structure, and not because the software requires some programmer or systems analyst to predefine the field combination.) Any "field" may represent a simple value (of dynamically variable length), a range, a item in a list, or even a complete file! Under most circumstances the order of the "fields" in a "record" is immaterial, although by having the NAME item first it can be shared between a number of "records" without needing to repeat it..

Such an approach is in marked contrast with the conventional database approach, which originated with the pre-computing 80 column punched card, with predefined columns. This fixed format approach was adapted to early disc-based systems, where fixed sized records allowed faster access with the comparatively limited hardware involved. (It is worth noting that in the UK many early computers used paper tape rather than cards and this lead to the development of variable format systems. Unfortunately these flexible techniques were "lost" because of the over-powering influence of IBM and fixed format languages such as COBOL.) The fixed format idea then became enshrined in relational data base ideal, which evolved to handle the well-structured tables of data which which characterised most early data processing. More recently the spreadsheet has become popular, encouraging still further the idea that the idea that data is best handled as a regular array.

In trying to teach the MicroCODIL approach I have discovered that the "arrays of little boxes" approach is as deeply embedded in many otherwise very competent computer programmers' minds as the QWERTY keyboard is for a touch typist. A similar effect is noted with many users of personal computer data base packages, and I have been fervently told on many occasions that it is impossible to use a computer to handle data unless the records are predefined, and often that fields must have predefined types and lengths. If I can persuade such a person to use MicroCODIL they will admit that it has the freedom they previously denied as impossible - but seem almost incapable of making use of it. For instance they will create a file with no "explicit predefinition" but in which every "record" contains the same "fields" in the same order. This kind of mental block can occur almost irrespective of the individual's previous computer language, ranging from COBOL to PROLOG.

The question of programs and rules in MicroCODIL also causes considerable problems. In MicroCODIL there is is a knowledge base which contains files of items - and there is no formal distinction between rules and data. Processing takes place merely by comparing files (often recursively) item by item. ANY file may be used as data, as a set of rules, or as a boolean condition returning *true* or *false*, and in many applications there is nothing that looks like a program. Many people experienced in procedural programming find considerable difficulty in unlearning the idea that applications must have a clearly defined set of rules.

For example one experience COBOL programmer decided to learn CODIL (MicroCODIL's main frame predecessor) and set out to implement a simple application in both CODIL and COBOL. After a short time he reported that it was so easy in CODIL that he wouldn't bother to do it in COBOL. On examining his working package I observed with surprise that he had tried to use CODIL as if it were a COBOL interpreter which did not require a predefined data division. When I explained that virtually all his "code" was redundant because CODIL would would carry out many of the operations automatically he threw up his hands in utter disbelief. Other sare often puzzled by MicroCODIL because they cannot find the application programs which they assume must exist somewhere.

Basically the problem seems to be that exposure to a wide range of computer programming languages and/or software leads to a QWERTY type mental block where it is assumed that, because all the application programs and file structures they have encountered have to be rigourously predefined, all computer applications MUST be constrained in this way. Even when it is demonstrated that these constraints can be relaxed, the programmers' training and experience force them to only select well-structured tasks which can comparatively easily be predefined. It is almost as if contact with computers has lead many people to reject open-ended solutions to open-ended real world problems as a valid area for computerisation - to the point where they either reject them or feel obliged to try to rationalise them into a well-structured framework.

It is easy to see how this has happened. Historically, the early computers were designed for well-structured problems, in which the rules were readily specified and the data could be treated as having a regular arrangement. These computers attracted applications which fitted the "early computer" conceptual model, and also attracted, as programmers, people who found it easiest to identify with the conceptual model. There was so much to be done that the next generation of hardware and software basically extended the original framework, and this has continued because, through inertia, it is easier to continue in the same direction. without realising that some of the "sacred cows" of computer science were artifacts of history, in the same way that QWERTY is.

Of course not every person working with computers is infected with the "little boxes" approach. Certain large database applications, such as library, museum and archaeological record keeping, are based on variable structure records because a conventional "fixed" approach is obviously inappropriate to the task in hand. Despite the significant amount of work done in this field, it is interesting to note that it has almost totally been ignored by the majority of data base theorists, who would seem to prefer to work with data which fits with more sophisticated mathematical models.

Conclusion

The computer industry is currently in a technology driven stage where new hardware and software ideas are introduced before their benefits and limitations can be fully assessed. The speed of advance is such that it is impossible for individual companies to continually keep up with the new developments and produce usable results. As a result that companies tend to select a particular programming language, or set of packages, and to stay with this until obsolescence forces a radical change. This means that many employees are faced with perhaps five or ten years working with, and gaining considerable skill on, a particular system only to be faced with a radical shift to something new when their old skills become redundant. Some, unfortunately will not make it.

This situation suggests that it is necessary to introduce more education for change into computer oriented training. Programmers and users alike should understand where the systems they use fit into the general framework of computing, and in particular where difficulties are due to the the generation of technology they are using. Unless this happens the computer scene will be littered for many years with modern versions of the the QWERTY syndrome - but are a far higher, and hence more blinkering - level.

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COURSEWARE DEVELOPMENT - MYTHS AND REALITIES

by

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Abstract

The development of instructional courseware represents a collection of many techniques, strategies and principles. Theory concerning the development process abounds but factors such as developers' knowledge and experience, timeframes imposed, availability of subject matter expertise, the sophistication of development software and productivity tools all have a role to play in the outcome of the final product.

In practice, and with unforeseen variables waiting to influence an instructional strategy or a development ratio, it is not always possible to bring the theory together, at least in the manner expected. Forecasting and coping with the variables adds a challenge to the activity which is difficult to quantify.

This paper is concerned with skills; the knowledge held by courseware developers and application of that knowledge to the successful production of courseware materials. It establishes core competencies for courseware developers, discusses the human resource problems and pitfalls outlined in the literature and demonstrates relevance in the light of experiences establishing the Commonwealth Bank of Australia's large scale courseware development area.

Introduction

The establishment of a Computer Based Training (CBT) courseware production facility represents a very large investment which will only function as well as those who work in it. Those resources demand much care and attention and continuing training and development. Individuals with appropriate skills and experience will make CBT successful.

There has always been ill conceived opinion, and evidence remains today, that courseware development involves little more than sitting at a computer and "producing" material. The instructional processes involved tend to be lost within the excitement of technology. One can assume there is a lack of understanding of what instructional designers do. This lack is pervasive. A decade ago the following comment can be seen to hold relevance today, "Even now, when it is widely recognised that programming expertise alone is not enough in courseware development, there still appears to be emphasis on 'authoring CAI programs' than on 'designing instructional courseware'" (Roblyer, 1981, p.174). Referring to concerns about the lack of experienced courseware designers in the United Kingdom, Heaford (1983, p.208) said it does not matter which authoring tool you intend to use because you will still need to study the quite different skills associated with instructional design before you start using the tool.

The skills of a courseware developer represent, in the first instance, instructional theory, processes or design. Secondly, the transformation or sequencing of instructions and their interrelatedness into interactive, intuitive material through a range of presentation skills and techniques.

The competencies for the instructional design aspects are well documented (International Board of Standards for Training, Performance and Instruction, 1986). As far as courseware development is concerned, Gery (1987, p.153–164) sets out the various roles required. The competencies put forward in this paper have been derived from experience associated with establishment, and now on-going management, of a courseware development team at the Commonwealth Bank of Australia. One of the unique features of this establishment is that the foundation team was, and subsequent team members have been, recruited from a pool of people who joined the Bank as "career bankers", not necessarily training technologists. Many developed, during their early career, a genuine interest in the training and development function while others "found" a niche.

It was necessary in the founding days to develop a team from scratch. This was completed with the assistance of the AIS II Authoring System vendor, McDonnell Douglas Corporation (USA). However, since that time in 1985, it has been necessary to develop our own internal courseware development training course. This has represented a considerable investment in developing new and scarce skills to grow the talent needed to sustain and fuel future expansion.

To set the scene, consider what Kearsley (1984, p.188–189) says "Training is presently balanced on the cusp between a craft and a technical discipline. In the past, good training has depended almost completely on the creative talent and unique experience of classroom instructors. Today, we see the emergence of instructional technicians who follow common procedures and produce training materials of consistently high quality."

Instructional Design

Briggs (1977, p.xx) defines instructional design as ". . . the entire process of analysis of learning needs and goals and the development of a delivery system to meet the needs; includes development of instructional materials and activities; and tryout and revision of all instruction and learner assessment activities". However, within the context of courseware development there is a need to expand the focus towards the systematic production of material.

The term Instructional Systems Design (ISD) embraces the flavour intended. Romiszowski (1981, p.10–11) makes the point that thinking in systems terms helps us to define and analyse the problem, identify alternative solutions, select among the alternatives and develop the most viable solution "mix". He goes on to say "it helps us to implement the solution and evaluate its effectiveness and real worth".

ISD is generally presented in five major phases — Analysis, Design, Development, Implementation and Evaluation. There are any number of documented ISD models which detail the steps within the above categories to varying degrees (Reigeluth, 1983; Merrill, Kowallis and Wilson, 1981; Dick and Carey, 1985; Campbell, 1987). Investigations conducted by Andrews and Goodson (1980) and Dick (1981) saw the development of a "generic model" (McCombs, 1986, p.69).

In the light of award restructuring and the recent Training Guarantee Legislation, accountability is today becoming the driving force behind training and specifically competency based training. People must be able to perform specific tasks to set criteria upon completion of training and be certified accordingly. Such accountability is more easily satisfied when the principles and processes of an ISD approach are applied because observable behaviour becomes the focal point.

There are two factors critical to the successful implementation of ISD in the context of courseware development. Commitment within the organisation is one. The development of ISD skills is the other simply because the skill is intrinsic to the function.

Breaking the phases of an ISD model into smaller parts and documenting these along the lines of a road map, would allow courseware developers to apply the steps, one after another. However, there is more required than knowing the ISD steps. Overall there is the knowledge and application of learning theories.

Within the analysis phase, researching, synthesising, planning, problem solving, information processing and decision making rank highly. Of special significance is the selection of appropriate media for the learning task. While this may not rest solely with the courseware developer, a firm understanding of the principles is essential. Most writers on media selection models would initially agree there is no one superior medium for all types of desired outcomes and for all learners. However, the courseware developer should be able to apply media selection criteria, at least in terms of broad categories. For example, physical attributes of the media; the learning outcome or desired performance of the student; and the characteristics of the learners. (Gagne, Briggs and Wager, 1988, p.204). It is often argued media analysis requires a skill demanding extensive practical experience in a range of training environments, but there are more scientific approaches and various models available (Reiser and Gagne, 1983; Dick and Reiser, 1989 p.86-101).

Within the design phase, critical skills include the writing of instructional objectives which mirror the task analysis work, the development of criterion referenced test items which measure the desired performances following the training, the development of learning and remedial strategies and the employment of methods for enhancing trainee motivation.

The development phase demands creative and crisp writing skills, the ability to foresee the use of graphics and the skillful use of an authoring system and/or language.

Implementation varies in accordance with the media utilised but planning and organising skills are pre-eminent to ensure courseware is available at the right time for trainee access. In the case of the Commonwealth Bank this involves the duplication and despatch of diskettes to branches throughout Australia for uploading to the 1200 stand-alone CBT PCs. (Spence, 1990a).

The evaluation phase comprises two parts. Formative evaluation where the focus is on the refinement of instructional methods and materials and summative evaluation which is concerned with the effectiveness of a course and the learning outcomes, the attitude of the students following the instruction and the overall worth of the course. Skills which encompass all other areas of ISD are generally accepted as the platform to carry out evaluation duties. The ability to investigate, question, interview, develop questionnaires, interpret results and draw conclusions is necessary.

There is little doubt ISD is the foundation of well prepared CBT of consistent quality. The availability of skills, as described, is vital to carry it through.

Team Environment

There has been much discussion (Applebaum, 1985; Bork, 1984; Hartman, 1981) concerning the benefits of a team approach to the development of CAI. Such an approach offers the ability to divide responsibility, resulting in improved development times and reduced individual burdens. Further, a team approach capitalises on the strengths of the team members, and the momentum provided by the team can maintain progress on projects that might have faltered due to waning interest or energy (Hannifin and Peck, 1988, p.70).

The team approach often documented generally consists of specialist instructional designers, subject matter experts, programmers, graphic artists and so on (Kearsley, 1984, p.180). Rowntree (1986, p.21-23) points out advantages and disadvantages for the establishment of teams and that success often depends upon co-ordination through a convenor with the right management skills to handle such a group.

It has been found courseware developers at the Commonwealth Bank appreciate opportunities to become involved with most aspects of the production cycle, which follows a relatively standard approach to ISD. Three courseware development groups are in place. To a degree they operate independently with each responsible for all aspects of ISD for the courses assigned. If circumstances permit, individual multi-skilled courseware developers are given the opportunity to follow the development of a particular module through each ISD phase until completion. This facilitates skill building, team bonding, and an added perspective of the complete production process. Strong ownership feelings towards a particular module have tended to increase commitment towards quality.

Under these conditions it is important the whole team operates with common project objectives and time frames clearly defined. Full co-operation between both individuals and groups, who share access to graphic development and system/technical support expertise, is essential. The control of work flow is particularly important for a number of reasons but among the most significant is ensuring adequate time for quality control checks.

Consistent with a competitive business environment unexpected staff shortages occur and product/procedural changes are notified at awkward times (usually just after the final proofreading has been completed). Re-assignment of tasks sometimes adversely affects the "ownership" principle and in these cases it does not take long to ascertain whether team building efforts are successful.

Courseware developers must be able to operate comfortably under these conditions, make a conscious effort to remain positive and mindful of the workload and timeframes affecting other people.

Creativity

Courseware developers can be expected to build material for a cross section of audiences. Age, educational background, experience and culture are some of the factors to consider. Courseware must appeal to these audiences, respect opinions, values and expectations. Delivery through screen based media adds to the complexities.

To cater for the audience and a range of variables, courseware developers need to be creative; the business of showing imagination as well as routine skill. Gery (1987, p.36) points out, very simply, that "Creativity is difficult to create! It's an unstructured, frequently unconscious process". She goes on to say "Achieving creativity requires a combination of capability and orientation in the developers and the time, resources and a low-risk political environment". Creativity is important to the development of courseware but it can also be difficult to harness in a production environment where imposed time frames compete with quality, imaginative and certainly interactive courseware (Spence, 1990b p.922).

There are some routine ways of providing interactivity, but while it is well accepted interactivity is the primary basis for using computers in instruction (Kearsley, 1986a, p.13) there are areas commonly stated as providing interactivity which are quite dull. For example, within most authoring systems a variety of question formats are available to the instructional designer but, depending upon the ISD model being followed, only certain formats can be used to test the performance of particular behavioural objectives. An objective which includes a performance ". . . recall (by listing) . . . "could only be adequately tested through a constructed response (type) answer (Ellis, Fredericks, Merrill, Richards, Wood and Wulfeck, 1979; Dick and Carey, 1985, p.114). This tends to introduce a level of predictability from the trainee's perspective ie. that learning facts or remembering steps in a procedure will be followed by a test where such steps will be asked (from short term memory) to be listed. While not destroying the principle of this strategy, the courseware developer must find ways of presenting material and testing it in a variety of interesting yet adequate ways. The use of different input devices is possible, but also is the application of gaming, interactive sequenced graphics and simulation. In this regard, Alessi and Trollip (1985, p.273) warn that ISD provides little guidance regarding the more creative uses of the computer, such as simulations and games.

Creativity can be well demonstrated through the use of branching within a module. Kearsley (1986a, p.15) claims branching is the essence of interactivity.

Essentially, branching occurs in association with conditions the courseware developer puts in place. Through individual trainee performances, cumulative responses to performance situations, or the trainee's personal choice, branching can be designed in a variety of ways. Romiszowski (1986, p.299) observes "Branching decisions, to faster or slower streams of instructional presentation, can be taken on the basis of a cumulative analysis of several responses over time and not just on the last, possibly atypical, response made". The courseware developer's ability to create interactivity depends to a large degree on the sophistication of the tools being used. Romiszowski makes the point that, in practice, few CBT systems exploit branching possibilities to the full or readily provide for the integration of non-computer based media into a complex, multi-media, computer controlled, truly individualised system. The reason is possibly due to these systems being developed without an appreciation of instructional design and learning theory. Whatever the reason, the onus is on the courseware developer to use what is available to best advantage.

The skill in developing branching involves anticipating the likely paths trainees will require under certain conditions. Strong feelings of empathy towards the target audience are needed and much of this must be gleaned from evidence and documentation established during the analysis phase of the ISD approach (where communication and analytical skills are paramount). Entry behaviours, culture, idiosyncrasies, work experience and general background of the audience are important factors. A creative approach to the use of branching is a skill for courseware developers to grapple with and for the managers of courseware development teams to develop patience with.

Creativity in the development of courseware takes place through the exploitation of methods that allow interactivity. To begin to carry this out, in-depth knowledge of instructional processes, authoring tools and the content of the courseware (or access to subject matter experts) is essential.

There has been much discussion about the benefits of learning through experiences, by experiment, but significantly, in an unstructured learning environment. Learner control, which allows trainees to decide what they need from available instruction, has its roots in the branching capabilities of the computer. There are a number of dimensions to learner control which revolve around alternative paths available to trainees, the level of flexibility and areas of enquiry, perhaps ad hoc enquiry, and for end user computing, the depth of access to options like "Review", "Skip", "Help", "Test" and "Glossary".

As technology is integrated increasingly within work activities, existing technologies (expert systems, knowledge processors, hypertext systems) and new models allow us to merge learning experiences into the job itself. The use of Performance Support Systems, which are software tools designed to improve productivity by making available immediate on-the-job access to context sensitive information, learning opportunities and expert consultation, with the scope and sequence controlled by the user, are now seen as the ideal method of improving worker performance (Puterbaugh, Rosenberg and Sofman, 1990; Raybold, 1990). The success of these tools will depend to a large degree on the creativity and flexibility built into the architecture.

Conventions

When it comes to either instructional issues or the presentation (screen layout) of material, everyone has a different methodology and different standards to apply.

The establishment of conventions and standards has proven worthwhile, albeit costly in time and resource. At the Commonwealth Bank, the internally produced CBT Style Manual is now the most frequently used reference. Its use extends beyond screen layout and design conventions to quality assurance.

Not surprisingly, standards are not able to be developed before a good deal of experience in developing courseware has been achieved. Gery (1987, p.132) says "... it is important to establish standards, but only after you have sufficient experience to assure they are reasonable ... without some defined structures, models or expectations to work toward, new CBT developers typically flounder". Standards are not necessarily generic. They are often unique, reflecting the operating conditions of an organisation or culture and often course specific reflecting the content and/or expectations of the audience.

Quality assurance activities become painstakingly tedious if standards are not complied with, particularly where a large scale production environment is involved (Spence, 1990b, p.919; Riley, 1989) or where courseware needs to be produced in tight time frames (Reimer, 1990). In explaining the standards in use at Centerior Energy in Independence, Ohio, USA., Cunningham-Reid (1989) says "Courseware developers must be willing to either follow them or offer convincing argument as to why they are not applicable. This places us in a position of authority, while allowing for individual initiative and creativity".

At the Commonwealth Bank we have approached the situation in a similar way, with an exception. Our courseware developers "own" the standards; they participate in their establishment and maintenance. The result is that applying the standards is generally without drama.

Screen design is specialised. Galitz, (1989, p.9) in explaining why people have trouble with computer systems and the results of poor design, places the responsibility for that upon programmers, systems analysts, and system designers, who may possess extensive technical knowledge, but little behavioural training. He says, "Design decisions have thus rested mostly upon designers' intuition and wealth of specialised knowledge, and consequently, poorly designed interfaces often go unrecognised. The intuition of designers or of anyone else, no matter how good or bad they may be at what they do, is error prone".

Therein rests the case for the development of standards in screen layout. Success will be directly related to the quality of thought and consideration put into the establishment of those standards. Courseware developers must be able to adapt to these conventions, feel comfortable with them, respect them and have the ability to work with them with minimal constraint.

Interpersonal Skills

Interpersonal skills tend to be one of the forgotten requirements for courseware development, yet to be able to discuss matters ranging from instructional principles to the technical content of courseware is absolutely necessary.

As an analyst, information must be obtained from product owners, subject matter experts (SMEs), as well as those who implement the product. Interviewing skills built around the extraction of specific information is typical. In addition, decisions concerning the nature and background of target audiences are vital when establishing a strategy for dealing with entry level behaviours for a proposed training programme. This aspect, which leads to establishing the conditions, performance and criterion for instructional objectives, requires well honed communication skills.

Summarising the recent implementation of a course at Syracuse University (New York) in interpersonal skill building for instructional designers, established to raise the level of awareness of the importance of working with others for effective instructional development, Curtis and Nestor (1990, p.59) made the following observation. "One course in interpersonal skills does not create experts in human interaction. It does however raise the level of awareness of the importance of working with others for effective instructional developments . . . interpersonal awareness and skill building are essential components of a curriculum that prepares individuals for careers in instructional development."

Changing work priorities, brought about through a myriad of issues, results in courseware developers changing from a specific component of one module to another at very short notice. Due to the courseware developers at the Commonwealth Bank being skilled in the analysis, design and development aspects of ISD, it is not uncommon for the courseware developer to complete the task analysis for a procedure and within hours move to the on-system development of a completely unrelated module which has been altered due to a change in policy and requires priority attention. This interchange and application of varying skills across the entire team has proven essential to workflow, productivity and overall harmony.

In contrast to a classroom lecturer who is able to adjust presentation style and/or emphasis in response to questions, reactions, body language etc., the courseware developer must foreshadow, imagine and "feel" for the students and then convey this through a computer screen at a remote location. This demands a solid knowledge base of differing human styles and behaviours, mixed with courtesy and empathy.

Clearly, the development of courseware does not rest on instructional design skills solely (Spence 1990c).

Technical

The collecting, recording and prioritising of information, particularly during the analysis phase of ISD, demands appreciation of the potential and practical application of software packages covering applications such as word processing, spreadsheets, flowcharting and data bases.

As a pre-requisite, a very firm understanding of computing concepts, such as memory and storage options and capacities, operating systems and applications software is required.

Depending upon a number of factors and conditions, a courseware developer may be required to use an authoring system (generally menu-driven software), an authoring language (developed specifically for a particular authoring package), a general purpose language or a combination of these. There are valid arguments for all these approaches but the use of an authoring system allows for the software to be relatively easily learnt and readily used. However, in some cases added functionality is required and the use of a specific authoring or general purpose language is necessary to provide a level of versatility and sophistication not available through an authoring system. Of course, there are levels of complexity between authoring systems.

One important aspect to come to grips with is the technical background in computing required by a courseware developer. Although the complete answer probably lays deep within an array of variables, a more fundamental knowledge base is required before technical skills. That base consists of interpersonal skills of the ilk outlined earlier, particularly empathy, together with a strong desire to exploit well founded instructional processes through a systems approach to training. Too often we see the assumption that courseware development (or "CBT") requires, in terms of importance, computing skills followed by skills in instruction. If CBT is to gain the respect it deserves, within and without the training industry, that assumption must be reversed.

This is not to say a successful courseware developer is more likely to come from an instructional background than a programming background, or that it would be desirable to train an instructional designer in the use of an authoring system and/or language rather than to teach instructional design skills to a programmer. The major competency of the courseware developer is first and foremost instructional. Gery (1987, p.169) makes a strong point ". . . most managers limit their author development to training in the authoring system itself. This training is necessary but not sufficient for effective CBT development." To emphasise the issue, at the Commonwealth Bank, a courseware developer spends about three weeks learning to use the authoring system opposed to about nine months consolidating ISD skills.

In consideration of future delivery platforms, technical competencies will change emphasis as advancing technologies in areas such as communications, digitised storage and multi-media expand the possibilities for the provision of individualised instruction.

Emerging Competencies

Behavioural objectives and criterion referenced tests are the cornerstones of ISD methodology. Kearsley, (1984, p.89-97) in discussing the prospects for ISD provides an opinion that the methodology will continue to be refined and modified as it becomes more widely used in training systems. Further, after many years, training professionals are beginning to accept that designing instruction necessitates a systematic methodology and a set of integrated procedures. He says, "ISD is likely to become as foundational to training development as biology is to the practice of medicine or physics to engineering applications".

The refinement of ISD, and in turn the competencies of the courseware developer, will continue to evolve and this will be in concert with advancing technology. Productivity tools, increased functionality and capacities of authoring software and delivery hardware all spell an exciting and challenging future. ISD itself, an iterative but labour intensive process, has not escaped automation. The application of artificial intelligence to the discipline is receiving much attention in research circles. (Kearsley, 1986b; Bassagnet, Nodenot, Gouarderes and Rigal 1990; Purchase and Robinson, 1990; Sodoyer, 1990; Bento, 1990). Based on expert system technology, an innovative system called Automatic Courseware Expert (ACE) is currently being used in Australia to design and develop courseware with tremendous savings in development time. (McCann, 1990). Obviously a new breed of courseware developer with a new mix of skills will be required to meet the challenges.

From another perspective, the work of Carroll (1990, p.3) which puts forward a strong argument for minimising the obtrusiveness to the learner of training material, claims that while an ISD approach produces predictable training design outcomes, the success is only mediocre. He puts forward a relativist position with respect to instructional objectives and instructional techniques through an aim to teach people what they need to learn in order to do what they wish to do, and to design instruction to suit the learning strategies people spontaneously adopt. This approach is referred to as minimalist instruction and, in regard to the development of training for end users of computer software, the key idea is to present the smallest possible obstacle to learners' efforts, to accommodate, even to exploit, the learning strategies that cause problems for learners using systematic instructional materials (Carroll, 1990, p.77-78). Carroll argues that people learning and using a software tool are highly motivated to do something meaningful. The inference is people do not want to follow simple steps during a module of instruction. In fact they will not. An unstructured approach to both the development and delivery of training is advocated; traditional ISD is not favoured.

Carroll explains that a variety of ISD specialists were asked to review his approach and that many asked if a checklist of guidelines could be developed. He responds negatively and goes on to say checklists lead inevitably to a mechanical orientation to what must be a highly creative enterprise. "Checklists also inevitably entrain bloated instruction". . . the result is the instruction . . . ".will not only be maximally adequate (in the strictly formal sense of satisfying the checklists), it will also be maximally long, maximally wordy, include every possible qualification and exotic detail — in sum it will be quite unsuitable for human consumption." (Carroll, 1990, p.303-304).

It seems creativity will always be the key whether or not a structured approach to courseware development is taken.

Describing why we should have, and can have, self-explanatory systems that train while they work, Bentley (1990) urges organisations and software producers not to ignore the needs of end users for easy-to-use systems. As a proponent of Embedded CBT he says "The role of ECBT is to build a support service into the computer that is capable of making the functionality of the application system easily accessible to the user". (Bentley, 1989, p.18). The concept of Electronic Performance Support Systems (Gery, 1989a), which provide immediate, individualised on-line access to information, guidance, advice, assessment and monitoring systems, fall into the Embedded CBT arena. Gery (1989b, p.22) observes "There is little integrated information about or experience in designing and developing such integrated systems. The knowledge about components cross professional and organisational disciplines. In many cases, initial efforts will be undertaken by a single function within an organisation, and not all perspectives will be incorporated". She adds "The instructional designers must be members of the Performance Support System development team from Day one. They must establish component and content specifications from a learning frame of reference. Instructional designers must represent the learner needs to assure competent availability, quality and integration". (Gery, 1989b, p.23).

Training technologists and instructional designers have a major role to play. "CBT is expanding into a variety of different approaches rather than being a single instructional medium. As CBT practitioners, we need to start thinking much more broadly about the application of computers to training" (Kearsley, 1990). The use of interactive (laser disk) video instruction, expert systems and advanced tools such as concurrent authoring systems, demand a base of skills that differ from "traditional" courseware development.

Conclusion

The focus of this paper has been on the skills associated with instructional design and the application of those skills to the development of screen based instruction. The benefits of an instructional systems design approach to this have been highlighted and the skills required to bring it about discussed.

In contrast, the advent of minimalist instruction has been raised to demonstrate courseware developers work in an evolving environment, not only from a technology perspective, but in terms of understanding the very basis of instruction.

It really is a case of the courseware developer learning, unlearning and relearning through the inate wisdom of knowing when to abandon convention for the contemporary.

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COMBINING CULTURALLY APPROPRIATE APPROACHES AND INFORMATION TECHNOLOGIES TO DEVELOP STRATEGIES TO IMPROVE THE HEALTH OF ABORIGINAL AND TORRES STRAIT ISLANDERS

by

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Abstract

The current health status of Aboriginal and Torres Strait Islander people is similar to that experienced by people living in third world countries. This paper looks at the health needs of Aboriginal and Torres Strait Islander Youth and how some of these needs can be addressed using information technology for the creation of instructional material and the delivery of those materials.
The development of the computer package "Aboriginal and Torres Strait Islander Youth: AIDS/HIV What You Need to Know" by the Aboriginal and Islander Community Health Service, Wollongabba is used as a case study to explore some of the strengths and weaknesses of a systems approach to the development of computer-based instructional materials.

Background

The level of health of Aboriginal and Torres Strait Islanders is one of the lowest in the developed world. There are many areas of health that have been identified as requiring attention including general health, dental health, sexual health and nutrition. As with many other cultures the youth of the community are most at risk on the one hand but are most able to change practice and effect future generations on the other. The computer assisted instructional material that this paper uses as a case study, 'Aboriginal and Torres Strait Islander Youth: HIV/AIDS: What you need to know?' was developed by the Aboriginal and Islander Community Health Service, Wollongabba to assist in educating Aboriginal and Torres Strait Islander youth about aids.

The impetus for the HIV/AIDS program came from the perceived need to educate Aboriginal and Torres Strait Islander Youth about HIV/AIDS in order to reduce the impact of the disease on the communities. Officers of health organisations had noted that computers used in classrooms, learning settings or in leisure activities were well received by Aboriginal and Torres Strait Islander individual youths and groups. A decision was made by the Department of Health in Queensland to fund the development of a program to teach Aboriginal and Torres Strait Islander youth about HIV/AIDS and to place the funding and direction for that development at the Aboriginal and Torres

Islander Health Service in Wollongabba. This Health Service is a medical centre that caters for Aboriginal and Torres Strait Islander health needs in the Brisbane area.

This paper identifies in the first instance the process that was undertaken to develop the program and secondly details the educational strategies that were decided to be used in creating the educational experiences in the program.

The authors of the paper would like to point out that this paper is not an erudite discussion of the pros and cons of particular educational strategies that are used in the program nor a serious investigation of the appropriateness of a systems approach to the development of instructional software with Aboriginal and Torres Strait Islander youths.. It is merely a description of what the authors saw as happening throughout the development process in the hope that such a description will help other groups creating similar materials.

The Design Process

Following the decision to fund the development of the materials a committee was created that involved the Queensland Department of Health (the funding agency), the Aboriginal and Islander Community Health Service, Wollongabba (the directors of the project), the Queensland Department of Education and the Computer Assisted Learning Unit of the University of Queensland (project managers). This committee determined basic guidelines for the project and acted throughout as advisors to the project and as facilitators when resources of various departments were required.

Basic guidleines that were determined were that the material should address the main issues surrounding the Aids area in as culturally appropriate a way as possible and that the finished program should run on equipment presently available in schools and communities.

The original intention was to adopt a traditional model of creating instructional software with a team approach to the development and authorisation of a storyboard followed by the writing of the program, a period of trialling, any necessary adaptation and finally production and distribution of the product.

The CAL Unit at the University of Queensland was to manage this process with the Wollongabba Health Centre providing the resource staff (curriculum writers and programmers), general oversight and reaction to progress on the project where necessary.

In this area where relatively new technology was to be used as the medium for the creation of educational experiences it was imperative to find people with the right skills to do the job. In the ideal world of a systematic process model the curriculum writer needs to know the types of activities that are possible in the medium and the programmer has to be able to advise that suggested proposals for the storyboard are realistic and can be programmed within software, hardware and budget requirements.

In this development process the choice of both writer and programmer proved difficult and led to considerable delay in production of the final product. The first choices for both the curriculum writer and the programmer (both Aboriginal) did not work out and this delayed the project by approximately 6 months. The second and final choice of curriculum writer (D. Steele, one of the authors of this paper, of Aboriginal descent) provided the development team with a person whose knowledge of Aboriginal health matters was extensive and who had written instructional material for the video medium. However his knowledge of the information technology medium was minimal The first programmer that was appointed was trained in the authoring language by the Computer Assisted Learning Unit as part of the arrangements for managing the project but he was not able to continue past the initial stage of identifying a possible structure for the program. A project manager (S Murray, another author, non-Aboriginal) was appointed by the CAL Unit with the Aboriginal and Islander Community Health Service's approval at this stage and he also became the programmer when the first programmer left. This was the team that did the majority of the design and development work.

The curriculum writer was initially exposed to the information technology medium through other instructional programs written in the same authoring language that was to be used for this program.

The authoring language chosen was TenCORE Producer and this provided both reasonable programming power and relative ease of making on-going changes to the program design and the written words and graphic images on screen.

The writer consulted widely with Aboriginal and Islander groups and organisations involved with educating communities about HIV/AIDS. He also visited a number of aboriginal communities in the north of Queensland to gather information about Aboriginal conditions and expected experiences in the HIV/AIDS area. From this the team was able to develop a tentative structure that proposed 8 different sections for the program with a possible question and answer section. At this stage the curriculum writer was still very much unsure of the capabilities of the medium and was not sure how readable each screen would be, how screens in the different sections would be sequenced, how different sections would be accessed from a central menu or how a section that provided on-line assistance with difficult words would work.

It was decided to program the structure as far as possible and to include a number of screens so as to provide examples to take to the committee for reaction. In retrospect this was a very good line of action to take. It provided the development team with feedback from the committee about the structure but also gave some members of the committee their first look at computer instructional materials in this area. The committee were then able to make more informed comments on future versions. It also provided the curriculum writer with much needed positive feedback that he was on the right track and had the capabilities to get the job done.

At no stage was there a storyboard that was approved in the traditional sense. The process that was undertaken was essentially one of learning what worked and refining accordingly. While this may be considered inefficient in some environments there is no doubt that nothing effective would have been created if the curriculum writer was not allowed to develop his skills in the medium, and to refine, and sometimes restructure the content, as the project continued. This alternative process was one which the team, the directors of the project and the funding agency felt comfortable. In retrospect the curriculum writer was to say that the crucial turning point came for him when he constructed a large tree diagram with the introduction and menu heading the tree, and the seven sections with all the little boxes for screens sitting underneath. At that stage it also became became clear to him that while there was a sequence in the sections there was also the possibility of moving from one section to another to access information that may be needed to understand information on other screens. The KeyWords section then became an integral part of the structure of the program and solved many of the language problems that had initially been hampering development.

The majority of the graphical images to be incorporated in the program were drawn by an Aboriginal artist at Kamarga. This artist was briefed to provide images of adults, children, animals and borders that were obviously aboriginal. An early decision by the committee meant that the program was to useable on CGA graphics on PC computers. This meant that only low level graphics with four colours was possible . The images provided by the artist were scanned electronically and incorporated into the text appropriately. The move from a hand drawn medium to a low level resolution graphics package was not easy as lines and angles turn out rather chunky and sharp. On screen adaptation of the images with a graphics package was necessary in order for the images to have maximum impact. These changes were done by the programmer and retained as much of the original art form as possible. Subsequent viewing by the artist indicated that she was very happy with the result.

The pilot version of the program was produced and trialled with 15 Aboriginal and Torres Strait Islander youths at the Aboriginal and Islander Community Health Service. Their reaction was unreservedly favourable. The program was also viewed by 6 Aboriginal adults, 6 Aids Educators and 6 white Australian students. Minor spelling and wording were noted, some colours were changed and one graphic replaced.

Educational Considerations

It is often said that educational experiences designed for students should come from within the culture rather than from without. The intent throughout the development of this program has been that this should happen. The curriculum writer was Aboriginal, he visited many Aboriginal communities and spoke to community medical and Aids workers, the direction of the project was undertaken by the Aboriginal and Islander Community Health Service and the committee consisted of appproximately 50% Aboriginal and Torres Strait Islander people.

In thinking about the HIV/AIDS and the target audience of Aboriginal and Torres Strait Islander youth aged 11 to 16 it was clear that the team would have to take consideration of:

goals of the program;
student identification with the program;
cultural survival;
appropriate historical perspective;
language;
symbolism; and
need to encourage discussion.

The instructional design incorporated all of the above through such avenues as:

Use of Aboriginal and Torres Strait Islander art and icons on pages as frequently as possible. An Aboriginal artist was employed to draw figures, shapes and borders that were to be seen as definitely Aboriginal by the target group.

Sections with Aboriginal history and culture clearly identified were used as motivators for the target group to learn more about HIV/AIDS.

The use of simple English language with the support of a KeyWords section that explained unfamilar English words in terms used by Aboriginal groups.

The use of a question and answer section that was designed to be non-threatening and to promote discussion and to be helpful if wrong answers were chosen.

Sections where Aboriginal and Torres Strait Islander youth were encouraged to discuss issues with other persons in their communities or schools.

The Future

The Aboriginal and Islander Community Health Service are presently (January 1991) packaging the material in a plastic folder with appropriate graphical cover design and it will be distributed to schools with significant Aboriginal and Torres Strait Islander populations early in 1991. The program may also be obtained from Aboriginal and Islander Community Health Service. A further series of computer assisted learning programs concerning Aboriginal and Torres Strait Islander health (dental health, personal hygiene, ...) is being considered if funding can be arranged.

In Summary

Aboriginal and Torres Strait Islander cultures are very old. Computer technology is very new. Aboriginal and Torres Strait Islander people have only recently been introduced to this technology and can see that the two might complement each other so that a broad range of issues may be more effectively addressed. The authors doubt if the above process, as described in this paper, with the individuals and groups involved could have been shorter or more efficient. If another program similar to this one were to be produced, there would undoubtable be savings in terms of increased knowledge and expertise of particular individuals in the area. However the cultural heritage of Aboriginal and Torres Strait Islander groups is such that consultation is a major part of the process for making decisions and this made committee decisions, appointments of personnel, and commitment to first the structure of the program and then the final product an extended process. However the final product, 'AIDS/HIV What You Need To Know", will certainly prove to be worth the effort required and the time taken.

KEEPING VOLVO ROLLING: OVERCOMING RESISTANCE TO THE USE OF NEW TECHNOLOGY THROUGH A TEAM TRAINING APPROACH

by

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ABSTRACT

CADD technology is considered a fundamental tool in creating competitive design advantage for Volvo in Australia. Management expected full utilisation of this technology within 6-9 months of installation by a select group of 15 draughting staff, aged 25-47, with little or no hands on computing experience. Staff response to this initiative was one of concern, manifesting itself as resistance and scepticism to:

(i) the technology
(ii) the management and its strategies including training (based on past employee experiences)

The problem required a strategy that would allow for both the short and long term issues to be addressed. The paper discusses the chosen Training Strategies, their implementation and comments on their efficiency in achieving the required utilisation of the CADDS system.

* VOLVO = I roll in latin

Keeping Volvo Rolling: Overcoming resistance to the use of new technology through a team training approach.

CADD technology is considered a fundamental tool in creating competitive design advantage for Volvo in Australia. Management expected a full utilisation of this technology within 6-9 months of installation by a select group of 15 draughting staff, aged 25-47, with little or no hands on computing experience. Staff response to this initiative was one of concern manifesting itself as resistance and scepticism to:

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BACKGROUND:

Volvo, over the past twenty years has established itself as one of Australia's leading truck and bus suppliers. Its commitment to the local market is strong, as the establishment of Volvo's factory in 1974 demonstrates. Further, its success is due in no small part to the local design team who are able to custom build vehicles to client requirements using quality componentry supplied from overseas.

Volvo recognising that factors such as quality, innovation and technology are increasingly important in establishing and holding domestic and overseas markets have embarked on a program of upgrading design methodologies so that all subsidiaries had access to the latest information. In Australia this has meant the purchase and implementation of a Computer Aided Draughting Design System (CADDS) by the Product Development (PD) department based at the Wacol Factory.

Around the same time Volvo had, as part of its business strategy, identified the need for effective human resource development and in response to this a centralised (Sydney based) training function with performance based training as its objective was established.

The training department, responding to product changes, career requirements and organisational demands, operates both internally and externally, with adult training specialists providing advice and expertise. Their responsibilities included the design, development, presentation and evaluation of technical and non-technical courses. Research indicates that adults prefer a problem centred rather than subject centred approach and this assumption has influenced training programs at Volvo during recent times.

THE BRIEF:

It was in the capacity of internal consultant that the training department was asked to: "develop a CADDS training program that would ensure the PD department was skilled to a level where they would be eligible to attend the Advanced (Swedish designed) CADDS Training Course and able to successfully complete basic design projects for the local Australian market within one year of the system delivery date."

The real need of the brief was for training to partner management to develop and maintain an effective human performance strategy as opposed to the design and delivery of a course. There was an opportunity to demonstrate that effective human performance implies results in particular business results. Business results occur when skills taught in a training program transfer to the job and thereby yield improved performance. In this context, it is important to assess and modify the work environment as required since it has a key role to play in reinforcing the skills learnt. In this particular instance the training was not the end goal rather a means to an end, namely effective human performance. Despite the tight time frames the training department saw the opportunity afforded by the brief and jumped at the chance.

THE PROCESS:

The process used by the Training department is outlined in Diagram 1. CADDS Training Program Flow Chart.

The purpose, methodology of each of these stages and their outcomes will be briefly discussed.

Project Group:

To define brief, agree to methods, establish time frames and identify resources. A project team, comprising a Subject Matter Expert (SME-trained in Sweden) from the PD department and a training expert was established to develop a strategy and a curriculum proposal. A review procedure involving three members of Volvo management team was agreed to.

Needs Analysis:

To identify the entry level of the PD group, totalling 15 in number and ranging in age 25 - 47, a series of interviews, an on the job observation including a small range of diagnostic tests were carried out. It was found that the group had little or no hands on computer experience, were concerned about job security, the nature of the job, their ability to master the new technology and the support they would receive from management in terms of training courses and on the job (OJT) back up. During this phase, team members were free to discuss issues with the SME and Training Departments representatives.

Resource Assessment:

To identify the ability of training suppliers to meet curriculum requirements and to determine resources available within the company. Very few suppliers were able to meet the projects stated training objectives and only one was prepared to negotiate and modify their programs according to client (Volvo) needs. Volvo, Sweden was able to supply advanced training once draughtsmen had developed the requisite skills.

The SME was the 'find' of this phase of the process. He was a member of the PD team, who had been trained in Sweden. His credibility, locally and overseas was excellent and his commitment to and enthusiasm for the technology was inspirational. As the SME was located at the factory, a direct line of communication was established, both for the PD and Training Departments. This would be of great advantage in the co-ordination and evaluation of the program.

Proposal:

The final proposal demonstrated how 'The effective utilisation of a capital investment project by human resources: the case for CADDS training', would effect the bottom line. The major components of the proposal, included the nature and sequence of training courses (refer Diagram 2: The Training Implementation Plan) including the OJT component, evaluation and the utilisation versus non-utilisation costs of the equipment. After review the proposal was accepted and the plan implemented.

TRAINING IMPLEMENTATION

The successful implementation of the training (refer Diagram 2) required the entire PD departments commitment. Most of the department were aware that 'something was afoot' but, 'what exactly'. As a result the 'old grapevine' was in full swing. As a result, much of the early stages of this plan were aimed at communicating the vision and allaying employee fears and scepticism.

For a start, each PD member was formally invited to attend a presentation outlining the future of the PD Department.

The presentation, during business hours by management, the SME and Training Department, on where the technology fitted into organisational and business goals and the role each individual from PD would have was clearly outlined as was the training opportunity and time frames. There was ample opportunity for questioning over refreshments. This openness and commitment was essential for the development of individual motivation. As well, the presentation demonstrated that individual's input during the analysis phase had been considered and acted upon i.e. the plan was a function of the entire team's effort, and one of their number (the SME) had a pivotal role. The doubts were on a dive, team commitment to the project was on a rise.

This was followed by individual interviews of each affected employee so that queries could be answered and the appropriate entry level into the training program be determined. During this phase, carried out by the Training Department to ensure objectivity and a degree of privacy, concerns over 'inability' to master the technology were the main issues raised. It was made clear to individuals that they were being given the chance to learn skills and to develop them over a reasonable time frame. They were not going to be assessed against a co-worker, rather they would monitor their own progress. For this purpose each individual had their own file, complete with individualised programs OJT evaluation sheets and customised exercises. As a result of this interview phase, all PD individuals indicated a willingness to embark on the project ... the team was behind us!

From this point on the factory based program itself was co-ordinated by the PD SME who being there on the spot was available to answer queries and monitor progress. The impact that this person had on the success of the program cannot be emphasised enough. Having an expert on the spot meant that problems arising from 'in practice the theory is different' can be dealt with more or less immediately. Frustrations did not become huge hurdles. The SME was able to modify the OUT exercises to suit the individual's needs. As a result, each team member could see that they were making progress.

The SME also kept management informed of progress on a regular basis. This was clear to the PD team when the assignments they were allocated gave them opportunities to utilise their recently acquired skills. Such feedback was a powerful motivator.

Generically speaking, the training courses provided participators with specific skills and knowledge in a problem solving mode, followed by OJT training using specific job related examples. A specific number of exercises (which equates to hours on the system) needed to be completed by individual before they could attend the more advanced course.

All members of the PD team chose to attend the Introduction to PC's course which aimed to develop keyboard confidence in a one on one, non threatening/competitive environment. This was followed by a series of graded OJT exercises with individuals utilising pre-allocated computer time. Individuals found the provision of structures time on the job a real relief as well as a great opportunity. As a result skills were practiced and a procedure for equipment utilisation within the department was established.

The jump from basic PC literacy to Level 1 CADDS Training was considered too big in terms of adult learning theory - insufficient experience, and as a result a CADDS Concept course was developed which ensured that users could focus on knowledge and skill acquisition in later courses rather than be overawed by the technology.

All PD staff have completed up to and including the Basic CADDS course and the majority completed their 120 hours of OJT training prior to week 33 as required. As well, the Systems Administrators have completed their relevant training. A series of interviews and assessment of the nature of the work being carried out by PD CADDS systems users indicate that they are all sufficiently skilled and could attend the Advanced CADDS Course to be supplied by Volvo, Sweden. The requirements of the brief had been met.

It was thought that this training approach with its high costs and readily transferable, though highly specialised skills would result in the poaching of staff, or individuals marketing themselves. In fact, only 1 member of the team has left, but the remainder appear to have little inclination to do so. As a group they demonstrate increased levels of team cohesion, initiative, innovation and efficiency.

CONCLUSION

A year down the track and Volvo's commitment to new technology and a planned performance based training program has made a significant contribution to the future of truck design and production, both locally and overseas. It has required investment in training, changes in work organisation and recognition that communication in all its forms plays an integral role in the success of any venture.

In Volvo, training has affected the bottom line and in the business world that makes real sense, because if you 'think education/training is expensive, you should try ignorance'.

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CMI RESEARCH AT THE UNIVERSITY OF ALBERTA IN CONTEXT

by

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Abstract

The University of Alberta has a long history of the use of computers as instructional devices. It began in 1968 with the introduction of an IBM 1500 computer assisted instruction system and progressed though the installation of a CDC PLATO system which was subsequently removed in 1987. Management of instruction has always been a key element of any computer related research done at the University of Alberta whether as a part of large computer assisted instruction courses, or as courses specifically designed to utilize computer managed instruction. This paper presents a context for the study of computer managed instruction and reviews a number of the key studies in computer managed instruction at the University of Alberta. With the reorientation toward microcomputer based instructional systems, it seems propitious to summarize the research in CMI to this point in time.

Introduction

> Can researchers and teachers devise teaching-learning conditions that will enable the majority of students under *group instruction* to attain levels of achievement that can at present be reached only under good tutoring conditions? (Bloom, 1984, p. 5)

> A CBI system that replaces part or all of a teacher's instructional role will receive little if any long-term use. (Baker, 1981, p. 23)

The University of Alberta (U of A) has a long history of involvement in computer managed instruction (CMI). In 1968, the U of A received one of the first IBM 1500 computer systems. The IBM 1500 was designed as a complete multimedia computer assisted instruction (CAI) system, with a high resolution (by 1968 standards) graphics display screen, light pen, random access film strip projector and audio record/playback units at each student station. It also utilized a specially designed CAI authoring language, Coursewriter II. While many other designers of CAI in the 1960s and 1970s concentrated on building stand-alone modules to supplement teaching,[1] the orientation of authors at the University of Alberta was towards the development of complete courses where the computer performed all the mainline instruction, testing and record keeping. The philosophy of these courses was that the instructor should be involved only when the computer diagnosed that an individual student required remedial instruction or skill-based evaluation that the computer could not perform. This freed instructors to act as tutors, concentrating their efforts where they could do the most good.

As courses were developed during the early 1970s, authors began to realize that, while Coursewriter II provided good instructional capabilities, there was no predefined ability to manage the testing and routing of students through the course. Each author needed to build such CMI capabilities into the CAI code.

One of the first people to investigate the possibility of separating the models of instruction, including testing and prescription, from the actual content of the instruction was Romaniuk (1970). His early work on the *Versatile Authoring Language for Teachers* (VAULT) system was later identified by Fred Morrison[2] as one of the inspirations of the TICCIT System.

Between 1972 and 1976, an extensive CMI model and package was developed and applied to the theory component of six university nursing courses at Penn State University (Szabo & Estes, 1978). One of several unique features of this multi-year project was that it was delivered across a large geographical area using specially designed movile vans which housed the IBM 1500 systems and student learning stations.

Some of the earliest work in developing a CMI capability for the IBM 1500 was undertaken at the U.S. Army Signal Corps, Fort Monmouth, NJ (IBM, 1968). The source code was made available to the IBM 1500 community and was subsequently modified by staff at the Division of Educational Research Services (DERS) at the U of A to include a number of different CMI capabilities. Petruk (1975, 1978) used these modified CMI features as the basis for two sequential projects under the joint sponsorship of Alberta Advanced Education and Manpower and Canada Manpower and Immigration to use CAI to teach electrical apprentices at the Northern Alberta Institute of Technology. The instructional model used by Petruk (1978, p. 5) represented an advanced use of CMI within a CAI environment.

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[1] Kearsley (1976, p. 35) notes that of the CAI programs identified in the 1976 edition of the *Index to Computer Based Learning* (Wang) which reported average student completion time, 846 took 5 or less hours to complete, while only 25 averaged more than 50 hours to complete.

[2] A 1976 speech by Fred Morrison to the *American Educational Data Systems* annual conference in Minneapolis.

> In CAI, this traditional model is replaced by a competency-based model, which recognizes that time, not achievement must be the variable in any training program. A basic tenet of this competency-based model is that all personnel trained must attain a specified level of competence in relation to every objective specified in the training program, and that some will achieve this level of competence in a shorter time, by a more direct route than others. (Petruk, 1978, pp. 3-4)

At the same time, the National Research Council of Canada contracted with staff at DERS to develop a set of preliminary specifications for an instructional support system for NATAL-74 (the NATional Authoring Language). A great deal of the document (particularly chapter 5) is oriented towards the provision of CMI capabilities within NATAL-74 (Hunka et al., 1978).

By the time the IBM 1500 was returned to IBM in 1980, a number of courses had been designed and implemented at the University of Alberta in which the primary instruction was by computer. Hunka (1978) describes five of these courses in which the average student time to complete the course varied from 15 to 75 terminal hours. While all of these courses were considered to be CAI, they each contained a major CMI component.

In 1980 the U of A installed a CDC PLATO system. Among the many powerful features of this system is an integration of CMI with CAI. Because of the powerful software design and mainframe capacity, a prescription to an existing CAI lesson could be carried out immediately, subject to the control of instructor and student. Courses in textiles, anatomy, physical education, nursing education, and a variety of other CMI applications were developed using this system, and many were transported to other PLATO systems.

In 1987, the PLATO system was decommissioned at the University, presumably due to budget constraints. University president Paul Davenport stated in the *Edmonton Journal* on 29 April 1990,

> In the 1970s and the early 1980s the U of A was a leader in the use of computer technology for teaching and research. We were pioneers in computer-assisted instruction, the use of microcomputers, in computer-assisted registration and electronic mail. With the change in budgets in the later 1980s, however, the university saw that leadership, despite our best efforts, gradually slip away. (p. A7)

Learning Theory Basis for Individualized Instruction

Learning is significantly more **effective** when instruction can be tailored to the unique needs of each learner. For example, Bloom (1984) found that students who are individually tutored learn twice as much (score 2 standard deviations above) as students instructed in the conventional manner.

Learning is also significantly more **efficient** when instruction can be tailored to the unique needs of each learner. Studies of student-paced instruction (vs. instructor-paced instruction) show that students learn the same amount in 20 to 50% less time than when they are instructed in the conventional manner (e.g., Kulik, Kulik, & Cohen, 1980). Self-pacing is only one form of adaptation to the many individual differences exhibited in a typical classroom.

Research on learning severely challenges our conventional wisdom about instruction and learning, namely, that aptitude is fixed and places a limit on what our students can learn. This research has given rise to the testable hypothesis that given enough time and optimal learning conditions, most students "do have the potential to reach this high level of learning" (Bloom, 1984, p. 4). Carroll (1970) argued that aptitude could be redefined. "The amount of time that a student needs to learn a given task under optimal learning conditions, is, in the author's opinion, a reflection of some basic characteristic or characteristics of the student that may be called 'aptitude'" (p. 72). The deeper implications of the time dimension of learner aptitude has profound implications for the way we instruct.

What specific conditions of the learning process promote better learning? Bloom (1984) identified the six (after tutoring) most important alterable variables in terms of their effect on student achievement. These are reinforcement, corrective feedback, cues and explanations, classroom participation, study time on task, and improved reading/study skills. Let's now turn to the role of CMI in addressing these individual, alterable instructional variables.

The Role of CMI in Promoting Individualized Instruction

Computer managed instruction is a highly specialized application of the computer to assist in the process of managing an individualized instructional plan for students. It consists of two required functions. First, the computer tests the student to identify his/her strengths and weaknesses. The result is a **diagnosis** which indicates which objectives the student has and has not mastered. A unique dimension added by CMI is that the diagnosis is individually tailored for each student's pattern of performance. Based on the diagnosis, each student receives a computer-generated prescription, that is an individual course of study designed to help the student meet the specific unmastered objectives. The second function of CMI is, therefore, **prescriptive**. CMI is not simply computerized testing or item-banking as these do not provide individually-tailored diagnostic and prescriptive functions.

Competency-based learning/mastery imply a repeated cycle of instruction and testing until competencies have been met. The iterative nature of the computer offers tremendous potential to accommodate this cycle through its ability to adminster exams with little or no instructor intervention and to clerically process the data and present the performance results in a summary form to the instructor.

Hansen (1970) listed five major functions of CMI: (a) providing diagnostic evaluations with learning prescriptions, (b) counselling students about adaptive learning strategies and career development, (c) developing an optimal scheduling system to match students and learning resources, (d) maintaining an appropriate student instructional record system, and (e) limited use of CAI for drill and practice.

While the technology used to deliver CMI has changed dramatically since the 1960s, the structure and function remain the same. Two outstanding sources for information on the structure and functions of CMI are found in Baker (1981) and Allen (1978). Figure 1 represents the core structure of CMI. Note that CMI can be and is often used in conjunction with existing learning materials. Thus, an instructor can incorporate CMI without substantially restructuring his/her ongoing instruction. In addition, CMI makes mastery learning possible in that retests to determine when mastery has been obtained are much easier to manage (administer, score, document, and report) than are conventional classroom tests.

People learn best when they can be made to actively and consciously process the information they encounter when they encounter it. Conventional instruction discourages the individual from processing information other than by trying to copy it to short-term memory, which has been shown to be most ineffective (some would say counterproductive) to learning. The computer is unique among media in that it can interact with a student in a processing way (Martin & Szabo, 1990) and stimulate deep cognitive processing (Anderson, et al, 1975).

Most of the specific conditions (alterable variables) identified by Bloom (1984) can be enhanced with the use of CMI. Individualized reinforcement can be provided for each student, item, and objective through CMI. Similarly, CMI can provide corrective feedback precisely where and when it is needed, to the individual student. Cues and explanations can be built into the CMI application and presented only to those whose performance indicates additional help is needed. Student classroom participation is interpreted to mean the active cognitive processing of information by each individual student, irrespective of level of participation. In a CMI exercise, the student must be actively processing information at a significantly more intense rate than during conventional instruction. During conventional instruction, there are many distractions which often cause the student to miss what is going on. During CMI, the student's attention is directed to the task at hand (assuming the ability level of the student is reasonably matched with the difficulty level of the CMI items). There is less 'down time.' We now turn to see whether research supports these statements.

Studies

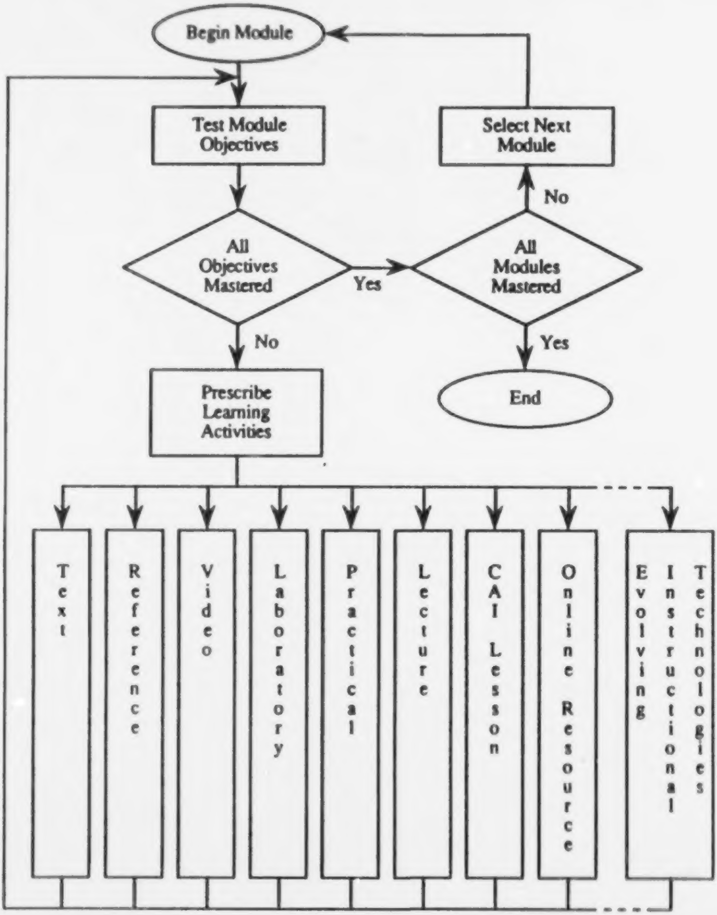
This section of the paper briefly describes a number of studies of the use of CMI. Studies undertaken at the University of Alberta or which U of A equipment or personnel were involved are emphasized. A few landmark studies undertaken in other places are included to place the U of A studies in context. For each study, we have briefly described the study, then discussed the findings and outcomes. A later section will amalgamate the findings of the studies.

Franklin and Marasco (1977) examined interactive computer based testing in post-secondary science courses. They identified (and exploded) five myths: (a) forcing students to use a computer presents an unwarranted additional obstacle their attempt to attain their educational goals, (b) computer based testing is crude and inflexible, (c) the use of computers is part of the mechanization and dehumanization of the educational process, (d) interactive computer based testing (ICBT) is too expensive, and (e) ICBT has serious problems with security and cheating. They also identified several advantages: ICBT (a) provides a broad variety of sophisticated tactics, (b) is amenable to virtually any educational strategy, (c) permits a more thorough integration of testing and teaching, (d) provides immediate and individualized feedback, (e) requires and promotes explicit pedagogical decisions, (f) allows excellent pedagogues to widen their audience and increase their impact, (g) has evolutionary potential, (h) has extensive record-keeping and clerical capabilities, and (i) is an economical approach to serious educational problems.

Several large-scale projects on individualizing instruction in the 1960s and 1970s found the computer to be valuable in managing instruction: Program for Learning in Accordance with Needs (Flanagan, 1969); Individually Prescribed Instruction (Cooley & Glaser, 1968); Instructional Management System (Silberman, 1968); and Computer Assisted Study Management System or CAISMS (Anderson et al., 1975).

Anderson and colleagues (1975) developed a computer assisted study management system (CAISMS) for use in a University of Illinois economics course. A well-controlled experimental research study was conducted among students in a large undergraduate course to compare students who used CAISMS with those who didn't. Students in the treatment group read study assignments and immediately completed on-line tests to assess their learning. Successful learning allowed a student to proceed through the syllabus, while unsuccessful learning required continued study of material already covered with retest opportunities. The treatment was developed in accordance with deep cognitive processing theory.

Results from this study indicated that students using CAISMS scored significantly higher on all course exams. One student's anecdotal comment is worth noting: "I really think CAISMS helped me a lot in this course, if not for anything else, it made me study regularly and be sure I got the right things out of what I read" (p. 8). Attitudes toward the course and method, as measured in the Anderson et al. study were significantly higher for the CAISMS students. Attitude scores for students was improved through the use of CAISMS


Begin Module
Test Module Objectives
All Objectives Mastered
Yes
No
All Modules Mastered
No
Yes
Select Next Module
End
Prescribe Learning Activities
Text
Reference
Video
Laboratory
Practical
Lecture
CAI Lesson
Online Resource
Evolving Instructional Technologies

Diagnostic and Prescriptive Model for Individualized Instruction

Figure 1

for large but not for small classes. CAISMS had no overall effect on course completion rate.

Tennyson (1981) addressed problems of learner control associated with CMI. He was concerned with research indicating that students may be incapable of making and carrying out "decisions of content element selection and personal selection" (p. 426). Specifically, students whose instruction is self-paced may terminate their study prematurely (before they have mastered the objectives) and may not assume proper responsibility for their own learning. The Minnesota Adaptive Instructional System (MAIS) was devised to indicate to students the discrepancy between actual and mastery scores, provide study assignments based on discrepancies, and continually update the student. The MAIS system was replicated in several different content areas using 12th grade students. The criteria consisted of several examination scores covering the content of the lessons.

The results of the Tennyson series of studies are notable for their direction and their explanation. Two groups received identical CMI instruction. One group received advice from the CMI system via MAIS, while the other did not. It was found that achievement scores were significantly higher for the groups which received advice to help them to decide when to terminate instruction and which content to study next when compared with those who made the decisions in the absence of any external advice. The comparison was made between students who could terminate their study at any time and those who received performance feedback to assist them to decide whether they were ready to discontinue instruction. It was concluded that the guidance function provided by the management system enabled high school students to make better judgments about their own learning and thus improved scores. The implication drawn was "students can successfully participate in the management of their learning when provided with their own individual diagnostic and prescriptive information" (p. 430).

In the Tennyson (1981) study, students receiving advice spent 30% more time on task than students without such advice. It must be remembered here that the comparison was not with conventional instruction time but with students in self-paced instruction where they could terminate anytime.

The Nursing Studies

Szabo and Estes (1978) reported on the comparative costs of developing computer based instruction materials. Data were taken from logs of a project in which six university bachelor degree nursing courses were converted to a CMI format on the IBM 1500 System for distance delivery using a mobile van.

A comparison was made between developing computer managed instruction materials and developing computer assisted instruction materials. The CMI development was based upon the use of existing instructional resources; none were developed. On the other hand, the CAI materials were developed from scratch. It was found that an hour of CMI student contact time was developed in an average of 39.7 developmental hours. In the same project, an hour of CAI was developed in an average of 161.5 developmental hours. These data suggest a developmental ratio of 4 to 1, favoring CMI over CAI.

Kot, Skillen and Wales (1986) conducted an evaluation of a PLATO-based CMI course in nursing at the University of Alberta. Forty-six students at the post-RN baccalaureate level were randomly assigned to either a conventional lecture/discussion treatment or to a CMI treatment for the theory portion of the course. After the course had been delivered on campus for several terms, it was delivered in a distant town using microcomputers, modems, and public telephone networks.

Achievement scores, as measured by midterm, final, and practical exams, was a dependent variable in the Kot, Skillen and Wales (1986) study. Achievement scores and learning time for the two groups were equivalent, indicating equal amounts of learning. The Kot, Skillen and Wales (1986) study examined instructor time and concluded faculty "spent twice as much time per student on instructional activities for the control group" (p. iii). This time savings worked out to about 35 hours per instructor per course for this particular study. When students kept student time logs, it was concluded that they spent equivalent amounts of study time in the CMI and the conventional instruction classes.

Day and Payne (1987) compared the use of lectures with CMI to deliver basic nursing content in the first year of a baccalaureate in nursing program. This study used the same CMI system and course materials as were used in the Kot, Skillen and Wales study. The major difference was that the Day and Payne study used first year "generic B.Sc." students as subjects while the Kot, Skillen and Wales study used post-RN students as subjects.

The Day and Payne (1987) study confirmed the Kot, Skillen and Wales (1986) results in that no significant difference in achievement was observed between the two groups. The study found that students learned equal amounts based on course examinations and clinical sessions.

In the Day and Payne study, there was an indication of less positive attitude among the CMI group, although no statistical analysis was presented. If indeed lower attitude scores were present, several alternative plausible hypotheses would need to be confirmed, for instance (a) the application was well designed (some right answers were counted wrong, no feedback given for wrong answers); (b) it was not used with the appropriate target audience (the course was designed for experienced nurses returning for academic upgrading-the sample was first year baccalaureate nurses); and (c) the majority of students had recently completed a high quality computerized testing program in anatomy and may have made unobserved comparisons between it and the nursing application.

Boblin and Gibson (1986) developed a CMI component for an anatomy and physiology course for diploma nursing students at the University of Alberta Hospitals School of Nursing. This component was developed using the PLATO Learning Management (PLM) program. The CMI component consisted of a module component and an exam component. The module component consisted of 21 modules which corresponded to the the subject areas taught. These modules were optional and were "designed to assist students in acquiring the course content and preparing for the exams" (p. 127). The exam unit consisted of six compulsory unit tests. Due to cost, a "picture book" was developed for student use rather than developing on-line graphics.

Boblin and Gibson (1986) found that students in the class using CMI achieved higher marks "for all of the unit tests, for the average of the unit tests and for the final course mark" when compared to the previous three (non-CMI) classes. An interesting problem which resulted from the use of CMI was identified:

> Historically, the A&P course has served as the "first screen" for students within the program. The subsequent levels within the nursing program are based upon student numbers and thus, are impacted by an alteration in the rate of attrition. The "expected" rate of attrition is approximately 7%, or 6 to 7 students. If the situation ... continues (that is, reduced number of students with difficulties), then the School will need to consider whether it wishes to have the A&P course continue as the "first screen" in terms of promotional criteria, or whether it will have to alter subsequent levels of the program to reflect this increased number of students. (Boblin and Gibson, 1986, p. 132)

Boblin and Gibson reported that students were more comfortable with computers after the course; instructors were not, and instructors reported fewer testing/retesting clerical duties and consequently more time for instruction (time estimates not identified).

Boblin and Gibson (1986) state that "Records on the PLATO system show that students spent an average of 2.5 hours/week on the system" (p. 95). Further, while specific time was scheduled into student timetables for access to PLATO, only 53% of students actually used PLATO most often during scheduled time. 95% of students indicated that the "...liked and took advantage of being allowed access to the computers at times other than those scheduled" (pp. 94-95). During the time of their study, PLATO was available 22 hours a day, 7 days a week, with up time in excess of 99.7%. Boblin and Gibson (1986) made an extensive effort to keep track of time and costs. Tables 1 and 2 report the manpower requirements and the total cost of their development of 21 modules and 6 exams. Discounting costs for hardware which was used for developmental purposes only, the cost to design the program and run it on a mainframe system for one year was under $30,000.The Alberta Vocational Centre Studies

The Alberta Vocational Centre/Edmonton (now Alberta Vocational College) has had a continuing its involvement with CBI. This originated because of the initial involvement of AVC/Edmonton in the Canadian validation of the Basic Skills curriculum delivered on the PLATO system. Fahy (1985) reports on the development of four CMI projects where PLATO PLM was piloted in existing adult basic education programs. Each of the four projects in the study was specifically designed to facilitate student self-direction and self-pacing in order to see whether current theory in adult education could be put into practice in an existing adult education program.In terms of CMI development time, other data are helpful.

Fahy (personal correspondence) kept a log of developing a CMI application using the PLATO PLM system and existing instructional materials. His data suggests that an existing course can be developed in CMI format in 5 minutes per test item. Projected out, a course of 1200 test items requires a development time of 100 hours. The U of A PLATO Instructional Systems Group commonly used the figure of 20 minutes per test item when bidding commercial CMI development projects for PLM. While this is four times the estimate of Fahy, it must be remembered that Fahy was using existing instructional material

Table 1[3]

Manpower Requirements Per Phase

Phase	**Hours**	**Cost**
Design		
study team members	86.50	$1,643.50
consultants	1.00	$60.00
subtotal	**87.50**	**$1,703.50**
Development		
study team members	721.80	$13,714.20
instructors	84.00	$1,538.04
secretaries	34.75	$343.96
consultants	1.00	$60.00
subtotal	**841.55**	**$15,656.20**
Implementation		
study team members	197.95	$3,761.05
instructors	16.00	$292.00
consultants	5.50	$330.00
subtotal	**219.45**	**$4,384.01**
Evaluation		
study team members	73.75	$1,401.25
subtotal	**73.75**	**$1,401.25**
TOTAL	**1222.25**	**$23,144.96**

Table 2[4]

Total Costs of the Pilot Project

Manpower	$23,144.96
Access through U of A facilities	$6,440.00
Macintosh to supplement access	$11,269.72
Supplies	$149.99
TOTAL	**$41,004.67**

in an internal development, while a commercial developer must be extremely conservative when estimating time and resources.

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[3] Extracted directly from Boblin & Gibson (1986, p. 105).

[4] ibid, p. 114.

With the success of the use of CMI with the adult basic education program, the AVC/Edmonton investigated the feasibility of becoming more involved in CBI. An external contract was let to undertake a study to "investigate and report on the feasibility of implementing computer assistance in operating and managing student record keeping and testing activities as a means of attaining program objectives. The study is to consider both administrative and educational management practices and needs" (Montgomerie, 1985, p. 7). The resulting study made six recommendations:

- AVC/Edmonton should incorporate CBI in the Nursing Assistant Program.
- Implementation should be phased in (CMI followed by CAI).
- A team (members with content experts, instructional design, CBI experts and management). Included was the recommendation of 1/2 time CBI coordinator and the establishment of a centralized instructional design group.
- Computing facilities should be contracted from some other institution.
- Plato CBI system should be used.
- No integration with the student information system, rather transfer information at specific reporting points. (pp. 85-87)

Alberta Vocational Centre/Edmonton did undertake a project to incorporate CBI in the Nursing Assistant Program. Fahy (1987, p. v) reported on this implementation:

> All but one recommendation of the Montgomerie report (1985) were met fully and one recommendation met partially in this PLATO-based CML implementation project. The unimplemented recommendation, reiterated in this study, was for an institutional instructional design group (with project management responsibilities).

Fahy (1987) gave a pre- and post-questionnaire to students . He reports that

> experience strengthened students' opinions that: PLATO was an efficient use of their time, was enjoyable, was interesting and was satisfying; PLATO was not slower than paper-and-pencil testing, did not make them nervous, was not too impersonal, did not make them feel isolated, and was not frustrating. (1987, p. 13)

Fahy goes on to report that, in interviews, students' major complaints about the PLATO system involved accessibility (number of terminals, hours of operation, etc.), privacy (dividers between stations, and "staff should not watch students over-the-shoulder while they are testing"), and lack of noise insulation (p. 14).

Fahy (1985, p. 16) found that "those [instructors] who actually experienced individualization in the projects found that computer management is capable of addressing many instructor reservations about, and of providing a relatively painless introduction to, individualization." Students were very positive about the use of CMI, reporting that they felt

> self-pacing lessened the disadvantage they faced, since they were not in competition with other, more fortunate students, and were working at a pace and on a schedule which recognized their own limitations. A second discovery was that students found learning from one another, or from the print modules, frequently more helpful and enjoyable than being tutored solely by the instructor. (p. 12)

Instructors reported fewer testing/retesting clerical duties and consequently more time for instruction (Fahy, 1987).

Fahy (1987, p. 21) compared the average cost per student using PLATO CMI with more traditional testing. The costs (in 1987 Canadian $) are summarized in the Table 3. The Police Studies

Szabo (1987) evaluated a project in which a major city police force converted its training section to CBI. The system made heavy use of PLATO-PLM; it also used CAI modules and short videotaped demonstrations. Thirty-two modules of instruction were converted from conventional instruction to CBI delivery over a 3 year period and the CBI modules were phased in as they were completed and validated. The evaluation study involved approximately 1100 trainees using the materials over a period of one year. As an experimental study was not possible, conclusions were drawn based on comparative data gathered during the six month period prior to the introduction of specific modules.

The Szabo (1987) study examined indicators of both paper and pencil exam achievement as well as selected on-the-job performance measures. In those measures available, trainees scored significantly higher if they were trained using CBI as compared with conventional (previous) training. Included in the data were such measures as scores on promotional exams, use of canine unit, number of arrests made using the canine unit, and fewer costly clerical errors on critical arrest warrants. The police department study resulted in the re-assignment of six full-time instructors to their regular duties after the CBI modules were fully operational. This resulted in significant cost savings, as the instruction normally required one full year of each instructor. In the police study, the CBI instruction resulted in an average reduction in student completion time of 25%. The salary savings from this reduced time plus other considerations led to the conclusion that the CBI system resulted in a cost savings of $350,000 over a five-year period.

Moisey (1988) undertook to investigate the effects of testing frequency and feedback upon achievement and retention in a series of CAI modules in Canadian law. A sample of 171 volunteer police officers in a large urban force were divided into eight treatment groups. Four variations of testing were provided: after each module, after two modules, after four modules or after eight modules. Every subject received the same number of test questions. Two types of feedback were provided: immediately following each item, or after a 24 hour delay. All groups had significantly higher achievement and retention (10 week delay) scores than pretest scores. No significant differences were found for test frequency or feedback on the pretest, achievement test or retention test. More frequently tested groups had significantly higher module test scores than less frequently tested groups. More frequently tested groups spent significantly less time studying CAI modules than did less frequently tested groups and groups which received delayed feedback spent significantly more time on tests than groups which received immediate feedback. Moisey summarized her results by stating that

> testing after each module coupled with immediate feedback clearly provides the most efficient training strategy. And, in comparison with other training strategies examined, it is also as effective. (1988, p. 133)

Computer Based Testing Studies

While we are careful to distinguish that computer based testing (CBT) is not CMI, there is a transferability of much of the work in CBT to CMI. Carbonaro (1988) undertook an extensive review of the capabilities of computerized test item banking programs and found fifty five individual features. He then surveyed 350 high school teachers in Alberta as to whether a computerized test item banking system would be useful to them and which features they would like to have. This study provides a comprehensive synthesis of computerized test item banking features.

Table 3[5]

Costs of PLATO-Based CMI and Other Delivery Modes

Delivery Component	Total Monthly Charges	Nursing Assistant Program Share	Pencil & Paper, with Scanner	Pencil & Paper, without scanner
Hardware	$765.00	$306.00	nil	nil
Subscriptions/ Supplies	$1050.00	$420.00	$150.00	$50.00
Telecommunications	$132.50	$53.00	nil	nil
Supervision	$623.63	$207.80	$965.16	$965.16
Scanning, scoring & record keeping	nil	nil	$71.00	$1008.00
Student allowances	nil	nil	$650.00	$650.00
Total Monthly Average Cost	$2571.13	$986.80	$1836.16	$2673.16
Monthly Average $/student	$17.14	$6.58	$12.24	$17.82

Rumbolt (1989) undertook a study of the use of CBT in an apprenticeship training program. The study compared two systems of administration of the same test – one in which on-line testing using *Quizmaster* (a microcomputer CBI program) was used, and the other in which paper and pencil tests (using the same questions) were generated using the *Computer Based Training System* (a mainframe CMI system). A quasi-experimental design was used in which the two experimental groups "flip-flopped" between on-line and pencil and paper tests. A third (control) group was given only pencil and paper tests.

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[5] Adapted from Fahy (1987, p. 21)

Rumbolt found no significant difference in the level of achievement between those doing on-line testing and those doing paper and pencil tests. Further, he found no significant difference in the attitude towards computers or in test anxiety between those doing on-line testing and those doing paper and pencil tests.

Rumbolt was particularly interested in actual cheating, or opportunity to cheat. No actual cheating was observed, and based upon responses to questions about cheating, Rumbolt states that "the on-line testing method was perceived as the system by which students were less likely to be able to cheat" (1989, p. 75).

Outcomes

An examination of these research studies shows that different studies concentrated on different aspects of CMI. The following areas were addressed by one or more of the studies: achievement, attitudes, cheating, instructor and student time, development time and costs, and delivery costs. Table 4 summarizes the results of the studies in each of these areas.

See Table 4

Conclusion

The research on pure CMI is thin. Much of the research on CBI includes components of CMI, so it is difficult to isolate the specific contribution made by CMI to the effectiveness of the instruction, attitudes towards computers, etc. Although there are single studies which do not confirm support for CBI, any scientist bases conclusions not on single studies but on the overall effect indicated by several similar studies. The very strong impression gained from a review of the studies reported here is that CMI has shown to be efficient, effective and relatively easy to develop compared with other forms of mediated instruction.

Experience indicates that CMI can be implemented by instructors, working alone or in teams. Aa team may or may not include computer analysts, depending upon the transparency and user interface of the particular CMI system being used. While there are

Table 4
Major Research Findings

Author	Achievement	Attitudes	Cheating	Instructor Time	Student Time	Development Time & Costs	Delivery Costs
Anderson et al (1975)	Students using CAISMS scored significantly higher than control.	Students using CAISMS had significantly higher attitude towards CMI scores than control.					
Tennyson (1981)	Students receiving computer advisement scored significantly higher than control.				Students under CMI advisement spent 30% more time on task than regular CMI students.		
Szabo & Estes (1978)						For an average module, CMI development took 39.7 hours, while CAI development took 161.5 hours.	
Kot, Skillen & Wales (1986)	NSD between lecture & CMI groups			Instructors spent twice as much time per student with the control group.	CMI& control students spent equivalent time (based on student diaries).		
Day & Payne (1987)	NSD between lecture & CMI groups	CMI students had a less positive attitude, but no statistical data were presented.					
Boblin & Gibson (1986)	Students using CMI had higher completion rate than previous classes.	Students were more comfortable with computers after completing the course. Faculty were not.		Instructors reported less clerical tasks with CMI, hence more time for teaching.	Students liked having an open schedule to undertake CMI.	Extensive records kept - see Tables 1 & 2.	Extensive records kept - see Tables 1 & 2.
Fahy (1987)		Students very positive about CMI. Instructors who used CMI were positive.		Instructors reported less clerical tasks with CMI, hence more time for teaching.		Estimated 5 minutes per test item.	Extensive records kept - see Table 3.
Szabo (1987)	Trainees using CBI scored significantly higher than control.			Six full time staff were returned from instruction to active duty as a result of the institution of CMI.	Student completion time 25% less for CBI		
Moisey (1988)	NSD for test frequency or feedback on the pretest, achievement test or retention test.				More frequently tested groups spent significantly less time studying CAI modules than did less frequently tested groups.		
Rumbolt (1989)	NSD between groups using on-line and paper & pencil tests	NSD between groups using on-line and paper & pencil tests in either attitudes or test anxiety	No observable cheating, but students seemed "less likely to cheat" when using on-line testing.				

advantages and disadvantages to working in teams, the former tend outweigh the latter. A comment often made within developmental teams is that one of the major benefits is the logical re-thinking of a course or curriculum required when implementing CMI.

CMI has been shown to be useful in the context of existing courses (e.g., Anderson, et al, 1975; Boblin & Gibson, 1986) as well as in brand new courses (Szabo & Estes, 1978). It has also been used as mainline instruction or as supplmentary instruction, (the latter required or optional)..CMI has been successfully applied over a wide range of content areas, ranging from nursing to special education to pilot training.

Although not systematically reported here, there is a rapid proliferation of microcomputer based CMI applications and programs as people begin to apply the microcomputer to the management of student learning. The only bit of advice we would offer here is for aspiring developers to carefully examine the features of the most outstanding mainframe-based CMI systems and avoid reinvention of the CMI wheel.

One might criticize CMI for being costly to develop and deliver. However, such conclusions need to be evaluated in the light of several factors.

1. In spite of years of formal instruction using conventional methods, there is not a clear picture of what it costs to create that conventional instruction.
2. The heavy effort is front-ended in the design and development phases (which can be condensed if a good pool of items/objectives/learning resources is available). Once the system is in place, it can be delivered repeatedly with minimal instructor involvement in clerical matters of test administration, etc.
3. The cost of computer hardware and software to handle CMI has steadily declined and by all indications will continue to decline.
4. There are costs which are incalculable but are much more important than hardware and software costs. One of these is the tremendous price Canada pays in lack of basic literacy, a problem which can be partially addressed through individualized instruction. In addition, what costs are paid by educational institutions which are unable to lead in instructional technology and, in many cases, don't even keep up to provide a good 'mirror' of society and its march to technology?

Regardless of what we as instructors would like to believe about our work, many of our students will do anything to avoid our lectures; most of which do not contribute as much to learning as we instructors would like to believe. The data suggests that CMI can play a useful and productive role while satisfying student urges.

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MAKING COMPUTER BASED LEARNING (CBL) HAPPEN
THE NGEE ANN POLYTECHNIC EXPERIENCE

by

Hock-Guan Tan
Yeow-Chin Yong

Abstract

This paper presents the experience of Ngee Ann Polytechnic of Singapore in the implementation and development of Computer Based Learning (CBL) and other related activities in the use of Information Technology. An overview of the CBL activities at the polytechnic since 1983 and its current status will be presented.

This paper will discuss the general strategies adopted in the past by the polytechnic and compare with those that adopted for the present development. It will also focus on the issue of integrating one of the CBL activities into normal course and our attempts in validating the effectiveness of Computer Assisted Instruction (CAI) as a form of remediation to assist our weak students. Both qualitative and quantitative results of the studies will be presented and discussed.

The paper will also address the issue of inculcating CBL cultures, a factor in making CBL happen. The present phase in planning and implementing Remote Learning via Teleview (the latest photovideotex system in Singapore) and "Distant Learning" via Singapore Public Integrated Services Digital Network(ISDN) will be presented.

MAKING COMPUTER BASED LEARNING (CBL) HAPPEN
THE NGEE ANN POLYTECHNIC EXPERIENCE

by

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Introduction

Making CBL happen in the Ngee Ann Polytechnic was an effort which began in late 1983. A working party was formed to look into CBL activities in Singapore and overseas. Based on the findings, the committee made recommendations for the development of CBL. A final report of the working party was produced in January 1986 [Wilson, 1986]. Arising out of the recommendations of this working party there were many developments on the campus. The production of CAI courseware and the installation of microcomputer systems and local area networks are the major ones.

In 1986 Ngee Ann Polytechnic embarked on strategic plans and the working party was reconstituted as a CBL working committee to undertake the following tasks:-

- identifying new CBL technologies;
- formulating strategies to increase CBL activities and
- encouraging faculties to be involved in CBL.

Since then, the CBL Working Committee has gone a long way in promoting CBL. Today the widespread use of microcomputer as a tool in teaching and learning on the campus is not an uncommon scene. The easy access to the various computer facilities on campus strengthened the rapid development and implementation of CBL.

The aim of this paper is to share with many others, in particular the educators, our experience of implementing and developing CBL on a large scale. Our belief and confidence to adopt the state-of-the-art computer technology compels us to step fast into the regime of information technology applications.

The effort to integrate CBL activities into the traditional tutorial classes illustrates our determination to exploit CAI to its maximum. The validation of the effectiveness of CAI in assisting students who find difficulties to follow the lectures paves the way for expansion programmes. These include the setting up of new CAI laboratories in each academic department, launching of Computer Based Training (CBT) Centre, implementation of "Remote Learning via TELEVIEW and partnership with a Japan computer industry in developing "Distant Learning" using ISDN.

CBL in Our Own Context

Computer Based Learning(CBL) can be defined in many ways. It can mean different things to different people. In Ngee Ann Polytechnic our working definition of CBL is defined in a rather general sense to refer to any use of the computer to enhance the teaching and learning process. In this definition we also include the use of the computer for administrative purposes like student and staff records, finance, and library access because one cannot really separate the administration of an educational institution from the teaching and learning that goes on in it.

The inculcation of CBL culture since 1983 had an enomous impact on the polytechnic community. Both academic and administrative staff are now competent in the use of computers. Input and processing of examination and test records, student attendance records and many others were computerized. In areas directly related to teaching, academic staff are increasingly using computer for the preparation and presentation of instructional materials. The effort of promoting the awareness of CBL to the polytechnic community has resulted in many areas of work being improved and enhanced through computerization.

CBL Activities at Ngee Ann Polytechnic

The polytechnic student enrolment increased exponentially from 3500 students in 1983 to 12,000 students in 1990. It it difficult for the faculties to provide personal attention to a large population of students. Computer Assisted Instruction(CAI) naturally becomes a good and effective solution to provide self-paced and individualized learning. There is no intention to adopt the electronic instructional materials to replace the faculties. CAI plays its salient role to supplement the traditional teaching at our polytechnic in which 100 to 350 students are gathered in the lecture theatre for mass lecture.

Courseware has been developed for remedial, instructional and tutorial classes. For the past 5 years, academic departments were active in the development of CAI software. Courseware in Mathematics, Physics, Principles of Electrical Engineering and Electronics are now widely used by students. The library developed CAI software on OPAC (Online Public Access Catalogue) and Library Guide to assist our students to source for references.

CAI has found a solid foundation within the polytechnic. A unique courseware writing guide recommending 4 basic design principles was proposed [Yong & Tan, 1988]. The principles focus on:

- man-machine interaction
- learner control of the learning process
- material organization
- well planned graphic display design

Computer Managed Instruction (CMI) is another activity that has been nurtured over the last 3 years. CMI is taken as a complement to CAI because our teaching environment requires the faculties to perform 3 basic functions:

- manage instructional delivery
- monitor student behaviour
- assess and record students' progress

CMI development requires the development of an item bank, performance analysis system, courseware and student management system. The English Language Centre(ELC) and the Mathematics & Science Centre(MSC) had begun some work on CMI three years ago. A Computer Based English Proficiency Test package was put on trial to assess our students' ability in technical writing and communication skills. MSC developed the student peformance analysis package [Yap & Yong, 1989] which could build student profile and analyse the quality of multiple choice questions.

Initiative is the key factor to promote the culture of CBL. The CBL Working Committee takes the initiative to introduce new tools to the polytechnic community through organizing talk, seminar, forum and demonstration. An in-house seminar on "Current Status and Future Directions of CBL" was held in 1989 to review the achievements of CBL at the polytechnic. The seminar provided the opportunities for faculties to analyse the success and failures in the development of CBL, make adjustments as necessary and prepare a new direction to meet the challenges ahead. Proceedings of the seminar [Ming & Yong, 1989] was published and it serves as a document to record CBL development and implementation at Ngee Ann Polytechnic in the 80s.

Validation Of CAI and Integration of CAI into Existing Curriculum

We conducted two experiments to validate the effectiveness of CAI to assist students who are weak in Mathematics. Both studies adopted a similar experimental model as depicted in Figure 1, with a slight modification for the second experiment. The validation is based on our measure and comparative study of the diagnostic tests prior and after the CAI induction course.

In the first experiment [Tan BT, Yong YC & Tan HG, 1987], the sample population were divided into two groups with one group of students scheduled for the CAI induction course and the other group of students deprived of the electronic instruction opportunity but undergone the traditional way of self learning. The findings are summarized in the graph shown in Figure 2.

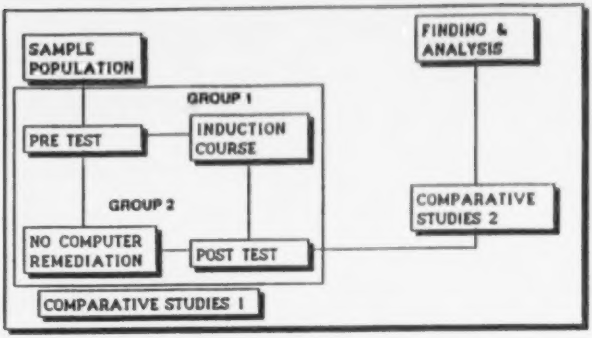
SAMPLE POPULATION
GROUP 1
PRE TEST
INDUCTION COURSE
GROUP 2
NO COMPUTER REMEDIATION
POST TEST
COMPARATIVE STUDIES 1
FINDING & ANALYSIS
COMPARATIVE STUDIES 2

Figure 1 : Experimental Model For Validation Of CAI

It is interesting to note that the two groups of students gained in the mean score after the post diagnostic test. The group that had undergone the CAI course captured a significant improvement in the mean score of 11.9% and the failure rate was reduced from 64.9% to 27.5%.

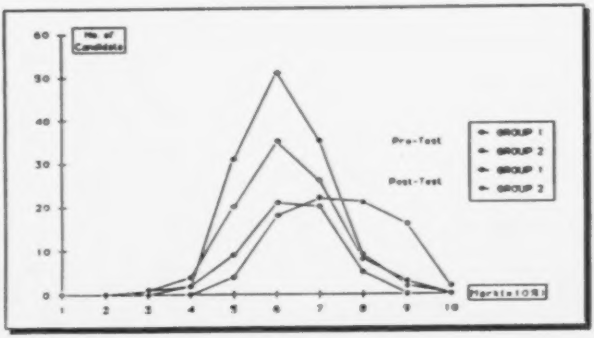

Figure 2 : Result of First Attempt in Validating CAI

In the subsequent study [Tan HG, 1989], the group of students without undergoing CAI induction course was scheduled to attend normal lectures conducted by faculty members prossessing a minimum 8 years of teaching experience. The students used the same instructional materials as those adopted for the CAI induction course. The result of this second experiment is tabulated in Figure 3. It shows that both the CAI group and non-CAI group improved in their performance irrespective of the mode of instruction. The students who had undergone CAI course achieved an improvement in the mean score of 11.[illegible] while the group which had undergone the normal classroom teaching made an improvement in the mean score of 14.9%. The diffrence of 3.1% is considered as insignificant. As such, one could deduce that a well designed CAI courseware could be as effective as a good teacher.

MODE of REVISION	Pre- test			Post-test		
	No	Mean	Marks<50	No	Mean	Marks<50
CAI	53	48.7	45.1	51	60.5	22.8
TEACHER	67	45.7	61.9	63	60.6	25.4

Figure 3 : Result Of Second Attempt In Validating CAI

Attempt was also made to incorporate CAI into the mathematics tutorial class. The traditional tutorial class was replaced by an environment in which peer tutoring cum interaction with computer through quizes were the dominant classroom activities. The verbal feedback form both staff and students involved were encouraging. The detail analysis of the study is still in progress.

New Strategies For CBL Implementation And Development

Looking forward to the next decade, the polytechnic sets new CBL strategies. A CBL steering committee was formed to review and revise the existing policies and guidelines. Directions have been set to focus on:-

- setting up of new CAL laboratories in each academic department to meet the needs and aspirations of the students;
- setting up of a Computer Based Training Centre (CBT) to provide the base for academic and industrial CBT development and collaboration in the region;
- partnership with Fujitsu(Japan) and Fujitsu(Singapore) in CBT and CMI development;
- developing Teleview "Remote Learning" and ISDN "Distant Learning";
- developing new CBL training and CBT project management programmes; and
- linking with overseas CBT research & development centres.

Building Blocks Needed For CBL Development

The descriptions in the earlier sections prompt us to identify key factors that made CBL happen. We view them as the building blocks needed for our CBL development in the 90's :

- Continuous effort in inculcating the CBL culture;
- Training and supporting our courseware developers;
- Hardware and software tools for development;
- Special interest groups;
- Links and collaboration with industries and academic institutions and
- Coordination.

Each building block serves as the basis of a comprehensive infrastructure to develop and implement a very large scale CBL.

Continuous Effort In Inculcating The CBL Culture

Inculcation of CBL culture is a tedious and no easy task. The effort must be continuous and we see it as a long term process. A series of awareness programmes must be carefully and seriously planned. The awareness must reach all levels of the polytechnic community. Top management's understanding of the importance and needs of CBL is essential. A strong support from the top management paves the way for an environment to nurture indigeneous CBL development.

Activities must be planted at the right climate and timing whereby supports and confidence in CBL can be built. We recommand the following activities :

- CBL fair to bring faculties and industries together to exchange views and experience;
- Technology product demostration to expose our faculties to the latest hardware and software tools;
- Talks on CBL by expert from overseas;
- In-house forum to access the success and failure of our CBL implementation and
- Top management meeting with faculties to discuss their support on CBL.

Training & Supporting Our Courseware Developers

In our polytechnic environment there is no special unit set up for the development of CBL. The CBL activities on campus is decentralized and yet centralized. Centralized in the sense that the CBL Working Committee receives feedback and reports from the departmental representatives sitting in the committee. Decentralized because each academic department sets their priority in CBL development. CAI software development and other application software development fall on the shoulder of the faculties. The courseware development is an additional task assigned to the faculties on top of their normal teaching load.

To sustain the interest in courseware development work, there is a need to train and support the faculties in courseware writing methodology and instructional design. The CBL Working Committee and the Educational Development Centre provide regular training and support to meet the needs of the faculties.

Hardware And Software Tools For Development

Any CBL project requires the support of hardware and software tools. As mentioned earlier the CBL activities are decentralized, diversification in the use of tools and hardware is anticipated. Such practice may not bring cost effectiveness and productivity in the development. A centralized effort to provide consultation in the use of tools and acquisition of the right hardware is a good solution. In our polytechnic, a CBL coordinator was appointed to work closely with the faculties to identify the physical requirement for CBL development. The coordinator is expected to form a team of experts to provide consultation and support to the academic departments. Such consodidation effort enhances the productivity in terms of sharing physical and human resources.

Special Interest Groups

Our definition of CBL is broad based. As such there are many interests among the faculties to work on different areas of CBL. The prominent activities are the development of :

- Computer Assisted Instruction(CAI);
- Intelligent Conputer Assisted Instruction(ICAI);
- Computer Managed Instruction(CMI);
- Remote Learning and Distant Learning;
- Computer Enhanced Teaching and Learning;
- Computer Based Training(CBT) and
- the use of computers as administrative aids.

We reckon the needs of the faculty members to form special interest groups. To sustain the interests of the groups, they will be encouraged to work on projects. The progress of the projects development will be monitored and financial support will be given whenever necessary.

Links And Collaboration With Industries and Academic Institutions

The polytechnic is in a good position to further enhance and develop CBL for the next decade. This is due to the following strengths:-

- good infrastructure of communication network on campus;
- established platform for CBL development;
- successful implementation of CBL on campus;

- faculties believe and are interested in CBL;
- top management's support; and
- easy access to computer facilities on the campus.

To further enhance the CBL development it is imperative for the polytechnic to establish links and collaborate with the industries and academic institutions. The recent partnership with Fujitsu (Japan) and Fujitsu (Singapore) to develop CBT methodology, CMI for academic and industrial environment as well as ISDN "Distant Learning" is a good example. Our faculty members work closely with the software engineers from Fujitsu. Such link brings benefit to both organizations. The polytechnic gains in the industrial experience of software engineering development while the Fujitsu taps our expertise in courseware development.

Coordination

Coordination ensures the success of CBL implementation and development. The Academic Planning Unit(APU) under the Deputy Principal's office embarks on strategic plans for CBL. It also plays the role to coordinate the CBL activities on campus. The CBL coordinator from the unit sits in the academic department CAI committee meeting to receive feedback and understand the requirement and aspiration of the faculty members. The CBL Working Committee reports the latest development of CBL and conducts forum, talk and CBL fair for the benefits of the polytechnic community. All activities are carefully planned and coordinated to ensure optimization of the human and physical resources available on campus.

We envisage that the success of CBL implementationin the 90's will depend very much on the development of the building blocks mentioned above.

Computer Based Training(CBT) Centre

In August 90, the top management allocated a substantial amount of funds for the setting up of a CBT Centre. The centre will serve as a base for collaboration with the industries to jointly develop computer based training programmes. Fujitsu(Japan) and Fujitsu(Singapore) are the first computer industries to have partnership with our polytechnic. The centre currently supports joint development in the following areas :

- CBT Software Writing methodology
- Integerated Computer Managed Instruction(CMI) System
- CBT Graphics and Routines Libraries
- ISDN Distant Learning

The layout plan of the centre(Figure 4) prepares our near future plan as the base and focus of regional collaboration in CBT development. Academic institutions and industries in the region could convene at the centre to discuss in CBL regional cooperation, disseminate information and exchange experience. The design of the centre is unique in its own sense as it encompasses facilities for developement, training, display of products and business discussion. It equips with the most up-to-date hardware and software tools and is a self-contained resource centre. Among the hardware installed are a high-end image digitizing workstations and a full color image scanner. By and large, the centre will serve as the coordinating body of CBL activities on the campus.

Remote/Distance Learning via Teleview and Integrated Services Digital Network(ISDN)

By "Remote Learning/Distance Learning" we mean students access learning materials, work on assignments and request for self-assessment at remote site such as home or work place through the use of computer and appropriate telecommunication media. The idea was conceived as early as in 1988.

To search for a cost effective solution, many testings were conducted at the polytechnic. They involved remote-PC to PC or remote-PC to file server communication via the use of data communication software through modems over the conventional telephone lines and public telephone exchange(Figure 4). Due to the large amount of data(caused by many graphics images in courseware) required to be transmitted over the telephone lines, the approach was found to be inappropriate because of the slow response time.

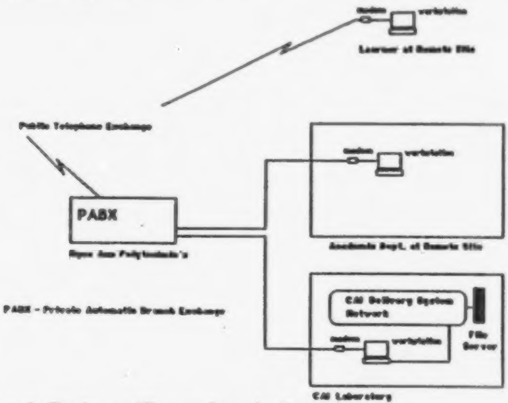
modem
workstation
Learner at Remote Site
Public Telephone Exchange
modem
workstation
PABX
Ngee Ann Polytechnic's
Academic Dept. at Remote Site
PABX - Private Automatic Branch Exchange
CAI Delivery System Network
modem
workstation
File Server
CAI Laboratory

Figure 4 : Testing on "Remote Learning"

In mid 1989, the idea of "Remote/Distant Learning" received new attention when Singapore Telecom launched Teleview, a photovideotex system of its own kind in the world. This is because while most videotex system world-wide tend to allow only simple text and mosaic display, Teleview is capable of display powerful graphics and photographic picture by using the television channel as the return path for retrieved information. This important feature reafirms our idea of "Remote Learning". Today, we are able to access self-pace learning materials via teleview from remote site using a PC with two PC adapters and PC Access Software installed. Our Computer Centre is developing a prototype system and it is anticipated that the services will be made available sometime this year.

Singapore Telecom also implements a nationwide ISDN, which is a single integrated digital network for all telecommunication services for voice, data, text and images. Over a high-speed fibre optic cable, the basic data communication rate can be as high as 64kbps. With two similar channels operate at this capacity and one other operates at 16kbps, the network provides a total transmission rate of 144kbps. There is an increase of more than 15 times in speed over those achievable on the existing switch data transmission network.

This tremendous increase in speed further consodidates our concept of "Remote/Distant Learning" as interactive lesson delivery would be possible. A joint development project with Fujitsu(Japan) and Fujitsu(Singapore) is now underway to implement a full scale "Distant Learning" via ISDN. The concept of ISDN Distant Learning is shown in Figure 5. A prototype of the system is expected to put on display in mid-March '91.

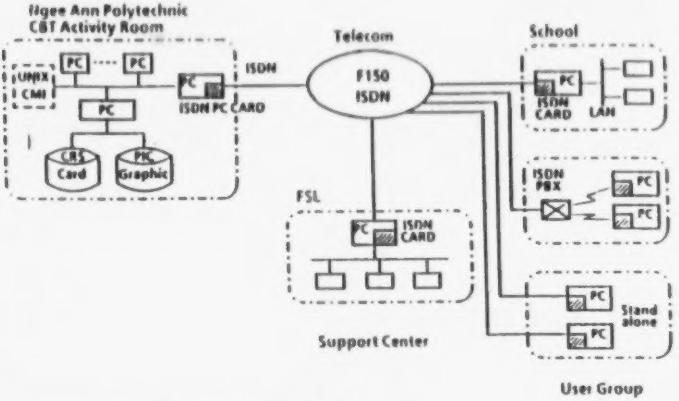
Ngee Ann Polytechnic
CBT Activity Room
UNIX
CMI
PC
ISDN
ISDN PC CARD
CRS
Card
PIC
Graphic
Telecom
F150
ISDN
School
ISDN
CARD
LAN
ISDN
PBX
FSL
ISDN
CARD
Support Center
Stand alone
User Group

Figure 5 : ISDN Distant Learning

Conclusion

Ngee Ann Polytechnic has made CBL happen. However, it is just the beginning. The era of information technology compels us to move fast to implement a very large scale CBL. The six building blocks serve as the driving force behind the development. Advanced technology, team work, international collaboration and industrial /academic partnership are the key players in the 90s.

We anticipate difficulties and resistance in making CBL happen. These are not reported in this paper. We believe that if there is a will, there is a way. And we shall overcome any problem that arises.

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POLICY MAKING FOR THE DEVELOPMENT OF *IT* IN SCHOOLS; THE PORTUGUESE EXPERIENCE OF PROGRAM *MINERVA*

by

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National Coordinator of MINERVA
Head of the Department of Planning
Portuguese Ministry of Education

ABSTRACT

Program Minerva is a national initiative supported by the Ministry of Education and devoted to the introduction of computers in Portuguese schools (pre-primary, primary, secondary and vocational sub-systems). This program started in 1985 and it includes nowadays a wide range of activities oriented to the full development and use of IT as comprehensive teaching aids. In this paper, a general perspective about the development of policy guidelines for this program is presented and discussed.

BACKGROUND

Nowadays, Portugal, as many other countries, is considering the improvement and the expansion of its educational system as the main road to speed up the process of integrated national development. A large plan for the development of the educational system (PRODEP-1990/1993) involving around 1400×10^6 US dol. and receiving the support of EEC structural funds is being implemented with this purpose[1]. In this context, the full exploration of the potential offered by Information Technology is a key issue.

From 1985 to 1988, an experimental project was introduced in pre-primary, primary and secondary schools achieving interesting operational results and creating the required motivation to launch a more ambitious and diversified program which has started in 1989.

In this paper, a synthetic description of major policy guidelines adopted in this program (MINERVA) is discussed and a few critical issues about the future are also discussed.

POLICY GUIDELINES

The introduction of IT in Portuguese schools is not an easy task as most of the teachers have no initial formation in this area and most of the facilities of the school network have insufficient quality (congested buildings, etc). Furthermore, the financial resources are inevitably scarce and short if compared to the huge existing needs.

Therefore, MINERVA is being conceived as a comprehensive program aiming to achieve the best and the highest impact of IT on our pre-primary, primary and secondary educational system using limited funds and involving multiple partners and resources.

Several major policy guidelines have been defined and are being implemented.

A. The development of this project implies a progressive and diversified strategy for extending the school coverage.

This means that delicate balances have to be achieved between primary and secondary schools, between urban and rural areas, between small and large schools.

B. The inclusion of a school in MINERVA implies, first of all, the decision and the commitment of that school to embark in this program.

This decision is not a bureaucratic procedure but rather it should be considered as part of the development plan of such a school demanding the allocation of priorities, energy, time and resources to this purpose.

C. The development of IT in each school requires a spectrum of resources such as appropriate rooms, hardware, software, and, most importantly, "teachware"! The formation and training of teachers is a key priority and hence the introduction of equipment without such activities is a waste of resources.

D. The basic sources of "know-how" to prepare teachers to make the best use of IT are the institutions of Higher Education.

Thus, a network of "poles" always located in Universities or Polytechnics are the supplier of the inservice training programs for teachers all over the country.

These programs consume a large fraction of the annual budget of MINERVA (> 30%) and so great care is taken to assure their efficiency. This means that:

a) an annual calendar should be available to help the process of communication between supply and demand;

b) evaluation procedures have to be developed and implemented.

E. The set of poles are the key infra-structure of MINERVA which means that each one should be a centre of knowledge and skills to promote IT in schools. Hence, MINERVA should encourage and support proposals presented by the poles to carry out research and development actually oriented to that objective.

F. A network of resource centres (CALs - Centros de apoio Local) is being developed to support many of the teaching activities developed by MINERVA, to train teachers. In many cases, these centres are located in key schools or in central places for areas with a more sparse school network.

G. High priority is given to the development in each region* of a comprehensive system including:

a) schools
b) resource centres
c) poles

This system should be considered part of the regional and local structures and facilities.

H. The generation of impacts requires the development of multiple lines of activities in the field of IT in schools which means multiple projects requiring different levels of funding and different actors.

Several projects have received high priority[2]:

- development of educational software (in Portuguese);
- development of courses on computer tools oriented to professional activities (IVA - Informática para a Vida Activa);
- "pedagogic mail" using Telematics;
- research on the use of IT in Special Education;
- improvement of the level of motivation in schools using IT. Each school in connection with other local, regional or private institutions can present a proposal for a specific educational project and funds are allocated through a national competition which is held every year;
- interchange and cooperation with other countries namely in Europe and in Africa.

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* Portugal has five "educational regions": North, Centre, Lisbon, Alentejo and Algarve, which are managed by Education Regional Directorates (Direcções Regionais de Educação).

I. Coordination of MINERVA by a central committee with responsibilities in the field of fund raising, policy making and monitoring/evaluation of the program. This structure is particularly well adapted to compensate regional discrepancies, misfunctions of the poles network, equilibrium between demand (schools) and supply (poles), contradictory interests of different professional groups (higher education staff, teachers of primary and secondary level, etc).

A major task of this committee is setting up feasible targets for the next years which always depends on the vitality of the program, the expectations from the educational system and from the society, the policy adopted by the Ministry of Education.

A key coordinating role is always played by the MINERVA regional councils which include representatives from different institutions such as the Education Regional Authorities (Direcções Regionais de Educação), the poles, the school network and other regional institutions.

THE FUTURE

The development of a program always implies the generation of innovative answers to meet new challenges and MINERVA is no exception. Nowadays, MINERVA covers about 900 schools and involves 15000 teachers per year on in-service training. However, in a few years we have to cover more than 2000 schools and more than 30000 teachers per year.

These targets require a substantial increase of the training work load and of the budgets allocated not just for acquisition but also for maintenance and substitution of equipment.

A large increase of activities carried out by the poles is quite difficult to obtain due to their limitations on human resources. The running budget of our Ministry of Education is always almost entirely devoured by the personnel salaries and hence the available funds for making the best use of existing facilities tends to be a vanishing component.

However, we believe that IT is having multiple seed effects and impacts enlarging the resources and the partners devoted in our society to this mission. This enlargement will start on secondary and vocational education and will also change the initial formation of teachers. The increase of links and joint-ventures between schools and the industrial, municipal or regional authorities will be a strategic instrument to achieve the proposed targets.

Therefore, and according to this perspective, the main challenge may be not a limitation of resources but the limits of creativity and ingenious spirit because we believe that, more and more, IT has to fulfil a role of interface and communication in our schools[3]. Interface between the classroom and the real world or between the model world and the physical universe. Communication between different specific scientific disciplines, classes of teachers, teams of students, schools, groups or institutions in different areas or countries. And also communication between schools and other community or regional institutions or organisations contributing to the development of a more balanced and harmonic education of youngsters.

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NEW PERSPECTIVES ON CML
THE NRMA EXPERIENCE

by

Ash Turner

National Roads & Motorists' Association

ABSTRACT

The National Roads & Motorists' Association, with over 2 million members, is one of the largest motoring organisations in the world. It is also the largest general insurer in the southern hemisphere employing nearly 4,000 staff in over 60 locations throughout NSW and ACT.

The NRMA has been using computer based training (CBT) to deliver almost 40% of its operational training for ten years. In fact, over the past four years alone, over 35,000 course completions have taken NRMA staff some 70 trainee years, using the 60 plus CBT courses that are available on the mainframe system.

With the opening up of the compulsory third party insurance market to the private sector in 1991, estimated monthly CBT usage is expected to peak near 3,000.

EARLY EXPERIENCES

The NRMA's early experiences with training and CBT in particular, saw a heavy focus on delivery of training, with little emphasis given to managing the resultant training information.

However, over the past few years, and in particular in the past 12 months, it has been realised that the power and benefits of using CBT to deliver training are matched only by its capacity to manage that learning.

The NRMA's early experiences with managing the vast amounts of its training information, were predominantly PC-based. However, this system was inflexible, information was difficult to access (in fact branch managers were not able to access directly any information) and the information was not transportable across other systems. To keep the information accurate, reports needed to be generated from the mainframe CBT system, collated by hand with information from traditional training, and rekeyed into the PC system. In order for this data to be integrated with Company personnel records (kept on mainframe) it then had to be downloaded from PC and uploaded again to mainframe. The process was time-consuming, labour intensive and because of the difficulty of transporting the data, information was either distorted or lost. There had to be a better way.

MANAGING TRAINING INFORMATION TODAY

The first stage was to exploit fully, the information management system that resides within the mainframe CBT system, for managing not only CBT information, but also information from traditional training.

The mainframe CBT was chosen because of our experience and skills in its operation, because there were low set-up costs (the hardware was already in place and easily accessible), because of the ease of transporting the data across other mainframe systems, and because of the ease of accessibility.

Today, our CBT system is the cornerstone of our system for managing training information.

Through a variety of programs and CBT courses we are able to manage both CBT and face-to-face training information, which is used to track staff usage and training times, cost training, monitor progress and completion of training, measure staff reaction to training, measure courseware development, maintenance and support, as well as to analyse and measure training needs and evaluate the effectiveness of our training. In fact, because of the power and ease of our training information management system, we have been able to embrace fully, a training philosophy that sees us not moving, unless we measure how far.

KEY SUCCESSES

There are three main areas of our training information management system of which we are particularly proud.

The first is in the area of staff reaction to training, both CBT and face-to-face. Within each CBT course is a program that essentially is an electronic questionnaire. Completion of this questionnaire is mandatory for successful completion of any course. Additionally, courses set up specifically to manage face-to-face training information, also contain the same evaluation questionnaire program. This data is captured by the mainframe, and after each month a report is produced that summarises the statistical analysis of this data in graphical form. This is only one form of evaluation that we use to measure the success of our training, and the power of our training information management system thus allows us to evaluate training at all domains - reaction, learning, behaviour and results.

The second area of which we are proud is in the way in which we have used our CBT system to manage the information for training needs analysis.

Competency-based models are designed using the CBT system, for a given task or job. These models are then completed by staff. Again, by using a variety of programs, this information is captured and on request, several statistical analysis reports are produced. These reports provide information as to the level of difficulty of the tasks, even down to a particular data input field. Additionally, these reports tell us exactly why those particular tasks are difficult. In this way, training can be designed that clearly meets the skills and knowledge gap. The additional benefits of this approach, and exploiting our training information management system have been reduced course design times, reduced courseware, greater relevance of training, the ability to capitalise fully on the existing skills and knowledge base of our people, and greater involvement, input and ownership of the training by those for whom it is designed - our people.

The third area of which we are proud is in the management of face-to-face training. Through specifically designed CBT courseware, all aspects of staff progress through training can be measured, monitored by themselves and managers, and evaluated.

All this information will, in the very near future be fully integrated with our personnel information system, expanding even further the use and management of our training information.

The success of our efforts will see us in the near future using our CBT system to manage non-training information in the areas of quality and communications, with the ability to create quickly, custom-designed computer applications, that fully meet the needs of users and that capitalise on their existing skills and knowledge.

All the while, we will be measuring and assessing all our efforts through the power of our CBT information management system.

SPREADSHEETS IN EDUCATION
POWER WITHOUT ENOUGH GLORY?

by

James Wade

ABSTRACT

Spreadsheets have an established role in a range of educational applications. However, recent developments in spreadsheet software have the potential for expanding these applications and for making the spreadsheet a more widely used tool. This potential is mainly derived from the availability of data management and graphics facilities within spreadsheets and of command language macros that can automate spreadsheet operations and thereby open them up to those with minimal skills in the use of computers.

This paper reviews the main educational applications of spreadsheets and demonstrates how these can be extended through the use of spreadsheet based data management, graphics and macro facilities.

In particular, the paper provides a re-assessment of the role of spreadsheets in:

- teacher developed educational software
- the teaching of programming fundamentals

The paper provides examples of how macros can be used to develop simple instructional software. It demonstrates the advantages that macros offer to teachers in the development phase of such software and to both students and teachers in the ease with which the resultant software can be used.

SPREADSHEETS IN EDUCATION
POWER WITHOUT ENOUGH GLORY?

by

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1. SPREADSHEETS IN EDUCATION

1.1 Productivity Tools

Given their business origins, it is not surprising that spreadsheets have found uses as productivity tools in a number of areas of educational administration.

Even though computer based productivity tools might not have the glamour and prestige of instructional software, they do have an important role, as noted by Chen [2]:

'School administrators are looking for ways to release both themselves and their teachers from routine clerical tasks and paperwork in order to provide more time for instructional concerns'.

He sugggests that common spreadsheet applications for teachers and administrators include 'gradebook keeping, budget and enrollment projections, mapping time on tasks for different instructional objectives'.

Schalkoff [3] sees a major application as being 'the preparation and analysis of grades and the effective monitoring of student and overall class progress.'

1.2 Mathematics Education

Probably because of the similarity between the tabulations found in business and those in many educational administrative applications, spreadsheets have found reasonably quick acceptance in the latter.

However, this business 'bean-counter' tag has probably impeded their penetration into more explicitly instructional applications. As Arad [4] notes:

'the majority of the people I encounter claim, «spreadsheets are primarily for business».'

Furthermore, in an 'editorial reflection' on Arad's contribution, the comment is made that 'the use of spreadsheets in mathematics is a relatively new idea' - and this comment was made in 1987!

Arad observes that:

"My first encounter with a spreadsheet program made a profound impact on my view of the potential uses of computers in my classroom. As a friend demonstrated the various options of Lotus 1-2-3, my thoughts began to race at speeds and in directions I never imagined possible. - « Neat! What an incredible tool; this is the microworld of numbers »."

"Using spreadsheets to help 10th grade students solve word problems, I now realize how powerful and motivating this tool can be."

In describing a standard word problem he notes that:

"Solving the equation correctly becomes the primary goal and the problem solving process is reduced to a computational activity. Mathematics teachers try to make word problem solution a process oriented activity by emphasising the importance of using heuristics...But learning to solve word problems by simply establishing and solving equations does not encourage nor allow students to explore and experiment with the problem."

"Spreadsheets offer an alternative method for solving algebraic word problems, allowing students to focus on the solution process and dynamics underlying the problem. The student can experiment and explore the word problem by entering different values in the variable cell and observe the related changes in the other dependent cells. The change is visible immediately; the problem becomes dynamic."

In applications such as this, the spreadsheet is essentially a cognitive tool in the sense used by Kozma [1]. That is it uses 'the control capabilities of the computer to amplify, extend, or enhance human cognition'. It functions by 'short circuiting task-relevant, cognitive processes so as to reduce the cognitive load on the learner and free up cognitive resources that may be used for other perhaps higher level cognitive processing'.

Khaira [6] identifies the following applications:

'Specific areas in which spreadsheets can be used include algebra including linear, quadratic and general polynomial functions; matrices and simultaneous equations; Newton's method for solving non-linear equations; applications of the Trapezoidal and Simpson's Rules.'

1.3 'WHAT-IF' - SIMULATION - CRITICAL THINKING APPLICATIONS

The ability of spreadsheets to present and answer 'what-if' questions makes them a very powerful tool for the development of educational simulations, particularly of the 'mathematical model' type.

Parker and Widmer [5] see spreadsheets as encouraging critical thinking and consider them to be 'adaptable to a variety of disciplines'. They observe that:

"The structure and capabilities of spreadsheet programs make them a powerful tool for encouraging students to organise data, pose and solve 'What if' questions, identify dependent and independent variables in real life situations and to hypothesize possible outcomes. In short, students engage in mental activities which promote critical thinking."

They warn that:

"This of course does not happen automatically. The problem must lead to exploration and provide for trial, examination of results and new attempts. To use the spreadsheet as an investigative tool, students need to work with carefully chosen templates. These allow students to enter and modify data and to interpret results and pose further questions without being burdened with the details of spreadsheet construction and formula development (each of which has its own curricular role)."

They emphasise the 'cognitive tool' and relief from 'computational burden' issues in concluding that:

"Whereas previously such explorations were impossible or at best terribly tedious due to the calculations involved, students now find a ready ally in an electronic spreadsheet. Changes and recalculations are accomplished with the strokes of a few keys."

While presented in the context of engineering, Bissell and Chapman's observations [7] are applicable to other areas.

They see the power of spreadsheet simulations coming from the fact that they are well provided with 'trigonometric, exponential and logarithmic functions as well as with a range of arithmetic and logic operations for combining such functions.'

In their summary they claim that spreadsheets are

- easy to learn, compared with computer programming languages
- are quick to implement and run
- can give additional information about how simulations evolve
- are an aid to understanding owing to the insights they give into the situation being modelled
- are highly motivating because of the above and because it is easy to try out ideas.
- are provided with better graphics facilities than many programming an simulation languages.

Chapra and Canale [8] view the advantages of spreadsheet simulations as follows:

"The computer speed and memory greatly extend our analytical capabilities. By removing some of our computational burden the computer allows us to place more emphasis on the creative aspects of problem formulation and interpretation of results.

Nowhere is this benefit more obvious than with the spreadsheet."

2. FACTORS LIMITING THE USE OF SPREADSHEETS IN EDUCATION

While the applications of spreadsheets in education have been acknowledged, as shown above, there is both anecdotal and documented evidence to suggest there are factors which limit the extent to which they are applied in practice.

Middleton [11] advances a likely reason:

'Students and teachers often wonder whether the productivity gains they may reap from spreadsheet software packages will justify the amount of time they'll put into learning how to use them.'

In using the spreadsheet as either a productivity or cognitive tool, its enhancement of human capacities can often be offset or even negated by the need to develop extensive spreadsheet operational skills.

For the 'traditional' non-automated type of spreadsheet, an extensive learning overhead is not only required by those developing spreadsheet models; but also by those using them; otherwise worksheet corruption and/or 'lock-up' is likely to result from user inexperience.

Middleton [11] contends that although 'most new users learn the packages in approximately 24 to 60 hours of keyboard time --- it usually takes 80 to 120 hours for users to view the packages as alternatives to manually preparing spreadsheets.'

Brown [9] observes that;

'Teaching a spreadsheet program to a roomful of students can be a real challenge. Such a program is difficult to teach; it can also be frustrating to learn.'

Johnson [12], in commenting on the use of spreadsheets for solving word problems (as presented in 1.2), raises a number of issues

"Who is responsible for constructing the spreadsheet template - the student or the teacher? The construction involves two phases

« 1) actually creating the visual format for the template as a representation of the given word problem »

« 2) implementing this format using a computer and a spreadsheet package. »

"The latter phase requires a reasonable understanding of the spreadsheet commands and can be very time consuming ---."

"Introducing spreadsheets into the mathematics classroom implies the need for sufficient student access to computers, the spreadsheet and the templates. Time becomes a factor as each student needs an introduction to the basic operation of a spreadsheet to understand how to manipulate cell values".

Thus a major impediment to the use of spreadsheet based productivity and cognitive tools is that spreadsheet 'literacy' is required by both developers and users and there is therefore a problem in getting untrained people to use them.

3. RELEASING THE POTENTIAL OF SPREADSHEETS - COMMAND MACROS

3.1 Generic Programs and Teacher Developed Software

Issues associated with teacher developed software have been discussed many times and quite diverse conclusions reached. Those against make odious comparisons between the 'quality' of teacher produced and commercially available materials and refer to costly redundancy of effort and materials. At least one strong argument in favour is, that in many subject areas, the size of the market is such that commercially developed materials are unlikely to be viable and courseware development will inevitably depend on teachers. Furthermore, as noted by Patterson & Smith [13], the 'use of a microworld' involves the concept of sufficiently limiting the environment to ensure it is 'conducive to constructive exploration' and this can often make specific purpose software insufficiently flexible or at least produce a need to develop simple supplementary computer based materials.

The above debate is generally presented in the context of major specific purpose software.

The term 'generic program' is used to refer to software, like spreadsheets, data bases etc., that can be applied in numerous problem contexts.

The widespread use of generic programs in business and industry, for coping with a wide range of day-to-day user specific problems, has parallels in education. It seems to me that, in this context, there is little doubt there is a role for teacher developed software. That is, for the 'programming' that is necessary to actualise the potential of generic programs so that it is directed towards the current specific problem.

Generic programs provide a vehicle for inserting a domain specific orientation into problem solving situations.

Widely used programs, such as Lotus 1-2-3 and Excel, are essentially spreadsheets. They activate their other functions from within a spreadsheet environment. Their success supports Chen's view [2] that ' the spreadsheet program on a personal computer is one of the quintessential problem solving tools in today's office'.

Rather than being placed last in the generic program trio of wordprocessor, database and spreadsheet, there is a good case for placing the spreadsheet first ! Of the three, the spreadsheet is the only one that can perform all of the functions of the others!

As noted in previous sections, because of the more obvious linkages with business practice, administrative applications have been more readily embraced and implemented. The potential for the use of spreadsheets in more explicitly instructional activities has been demonstrated; but difficulties in classroom implementation have been identified. Unlike other educational software, these appear to be mainly associated with program learning overheads for both the user and the developer.

The requirement for spreadsheet 'literacy' is inevitable for a teacher developing an application and this is true whether its purpose be administrative or instructional.

However, such demands on the user (students or other teachers) can be virtually eliminated by using macros to automate spreadsheet operations. Even though in the computer era time scale, the availability of spreadsheet macros is not recent, they do not appear to have made much impact on educational computing.

3.2 Spreadsheet Macros

A distinction needs to be made between two kinds of spreadsheet macros. In Lotus 1-2-3 terminology, the terms 'Command Language Macros' and 'Keyboard Macros' are used to identify them. In Excel, the corresponding terms are 'Command Macros' and 'Function Macros'. The latter kind are available in the current versions of most spreadsheet software and enable the recording or learning of a series of keystrokes that can be replayed as often as required at a later stage. This facility allows the automation of repetitive functions by reducing them to a single keystroke. As defined by Curtin [14], a macro of this type is 'a sequence of keystrokes that are stored so they can be executed with one key.'

Jones [15] summarises the distinction in the context of Excel as: "Excel macros come in two flavors: command macros, which simulate user actions by delivering a series of Excel menu commands; and function macros, which act on one or more values and return a value."

Command/Command Language macros function like a simple programming language, which is available inside the spreadsheet and which enables the program control to be automated, with the spreadsheet commands thereby becoming virtually transparent to the user. This enables quite complex applications to become more 'user friendly' and does not require users to be able to use the extensive array of spreadsheet commands to interact with the program. As Campbell [16] has noted in regard to Lotus 1-2-3 :

"Command language macros allow you to perform repetitive tasks with ease and automate applications so that even novice users can handle complex worksheet tasks."

Curtin [14,p.524] sees these macros as examples of fourth generation programming languages. He classifies the generations as :

#1 - machine languages
#2 - assembly languages
#3 - BASIC, COBOL, FORTRAN etc.

He claims that:

"The widespread adoption of microcomputers and widely available applications have almost eliminated the need for users and developers to use these programs (1.e.#1,#2 & #3). The reason is that many applications programs have a built-in programming ability. If the program has to be customised for a specific use, the user or developer can use these built-in languages to do the customising. These new programming languages are called fourth generation languages."

"One of the first programs to give developers this ability was dBASE II which had a very powerful, but somewhat complicated programming language. When Lotus 1-2-3 was introduced, it simplified programming by introducing macros, a way to write short programs that automated the spreadsheet. The final breakthrough was the introduction of the record ability. This feature allowed users to turn on record mode, execute the keystrokes they wanted to capture and then play them back whenever they were needed. The latest development is to combine record and programming so that you can record and then edit macros."

Macro command languages are available in all of the modern spreadsheet packages e.g. Lotus 1-2-3, Excel, Framework, Open Access etc.

I have used macros to automate spreadsheet based applications for both teaching and administrative purposes. These applications demonstrated how spreadsheet macros can facilitate the relatively quick development, by teachers, of simple educational software for use by students and/or other teachers with minimal computer usage skills. Their development proved to be far less time consuming than that required for similar programs previously written in Pascal and involved far less 'code'.

This type of teacher developed software does not require the development of the extensive 'programming' skills normally associated with the 'traditional' high level languages. Macros harness the powerful processing capabilities inherent in spreadsheet packages and in particular enable interactive features to be provided without users (other than the 'developer') being required to understand or use the wide array of spreadsheet commands.

Even though this type of material does not attract the attention and prestige given to large computer based educational software, it does have an important role in providing a quick but effective customised response to the solution of the range of relatively 'low-level' instructional and administrative problems for which specific 'commercial' software is either unavailable or inappropriate.

4. RELEASING THE POTENTIAL OF SPREADSHEETS - DATA MANAGEMENT & GRAPHICS

4.1 Data Management Facilities within Spreadsheets

There is a tendency, in considering the educational applications of generic programs, to present spreadsheets and databases as virtually unrelated pieces of software. Even when integrated packages (e.g. Appleworks, Open Access, Framework) are used, the integration is generally only considered in terms of facilitating compatibility of file transfer between package modules.

Retrieval of information from spreadsheets is generally viewed in terms of 'manually' scanning cells via cursor keys or use of commands (e.g. 'order', 'arrange', 'locate' etc.) to sort cells or find cells with specified attributes.

However, for many applications and particularly those with an administrative orientation, a spreadsheet is essentially database information displayed in a 'report' format - with rows and columns corresponding to records and fields respectively.

The designers of modern spreadsheets have recognised this and have provided built-in database facilities, that enable extensive information retrieval and manipulation to be achieved. Although programs, such as Lotus 1-2-3 and Excel, are labelled as 'spreadsheets', they provide data management commands, which allow the definition of and subsequent retrieval from a database within the spreadsheet model. Some integrated packages also have data management commands within their spreadsheet module.

4.2 Graphics Facilities within Spreadsheets

As Curtin [14,p.514] notes:

'Graphics for analysis programs are integrated into most spreadsheet programs so that data generated on the program can be quickly and easily displayed as a graph'.

Even though these comments are presented in a business context, there are parallels in education. Thus for example 'viewing the results of different scenarios' via a graph enhances the 'what-if' applications discussed in 1.3.

In general, the ability to quickly display spreadsheet data, in a graphical form, facilitates the interpretation of the key relationships imbedded in the spreadsheet row/column format.

5. SPREADSHEET MACROS AND THE TEACHING OF PROGRAMMING FUNDAMENTALS

Claims are made that 'programming education is becoming an integral part of today's schooling' [17]. Similar advocacy is presented in the introduction to the core 'Programming' topic in the NSW Years 11 & 12 syllabus [10]:

"The ability to analyse a problem and develop an appropriate solution in a systematic manner is fundamental to many of the aspects of computing which are included in this syllabus. Programming depends heavily on this ability and is seen as a valuable experience in developing the necessary attitudes, skills and understanding."

Programming is essentially the process whereby the potential of the 'universal machine' is applied to the solution of a specific problem.

At the beginning of modern computer development, programming required specialists to become fluent in the 'machine language' native to the computer being used. Assembly languages were then developed to make computer instructions better suited to human comprehension and this process was then extended to 'high-level' languages.

At all stages in this evolution, there have always been those who have insisted that competency in the preceding stage was still essential if students were really going to be able to understand anything about computers !

When computers were starting to make an impact in schools, BASIC became the language for educational computing, mainly because it was small enough to fit into the microcomputers of the time.

Because it was initially the only viable alternative, the use of BASIC became almost synonymous with programming in education.

For Weizenbaum [19] and others , 'BASIC is from a pedagogic point of view an intellectual monstrosity that we should --- not use as a basis for anything'.

Unfortunately, in education, the limitations of BASIC have tended to be transferred to the task of programming itself - resulting in laments such as the following from Brady et al. [20]:

"Programming has been taught in a very haphazard way in high schools, often with little regard for the structured programming debate which revolutionised computer science in the seventies. Many teachers have become disillusioned with the idea of teaching programming and Moursound has suggested (1984) that having taken a high school programming course may constitute a distinct disadvantage to those undertaking college computer science courses."

One type of solution has been to move towards more structured languages, like Pascal.

However, there is evidence of a realisation that the real cause of the problem is an unjustifiable tendency to equate programming with a detailed knowledge of a language.

As Lawson [21] has noted:

"In respect to the various computer related languages used to create hardware and software structures, we can observe that they definitely contribute to creating isolated specialist groups who can and the rest of the world who cannot."

"The way of attacking these barriers --- is not to rush in and learn the operational details of [computer] languages. In computer education too much emphasis has been placed upon the role of a programming language and early courses tend to concentrate on non-essential programming language details."

"There is no one best programming language; consequently, students should not be subjected in their early education to the details of a particular language."

A clue to an appropriate alternative is found in Lawson's observation [21] that:

"Programming languages are only one of several languages utilised in describing and creating the computer system environment. At virtually all levels of the software and hardware 'architecture', there exist languages used to describe the processes of the level. Thus we have application languages ---database languages, query languages etc.".

This view is echoed by Curtin's comment about '4th generation languages' to which reference has already been made in 3.2.

Braun [18] and Masterson [22] discuss the impact of time constraints and efficiency on the choice-of-language issue. The latter notes:

"Cost-effective programming languages in the context of economies of scale, demand machine efficiency at the expense of human efficiency. Machine-efficient programming languages tend to be inflexible and picayune, requiring several lines of code to accomplish even the simplest tasks. Programming becomes a tedious task prone to mistakes."

"An analogy can be made to ground transportation. Businesses use large trucks to transport goods as cheaply as possible. Who would claim that individuals should use the same vehicles to go to work or go shopping? FORTRAN, ALGOL, BASIC and Pascal seem like trucks. We need more 'automobiles' and 'bicycles': responsive, customizable programming for CAI and personal computing".

It seems to me that time constraint and efficiency considerations, in themselves, are sufficient reason to conclude that the 'traditional' high-level languages are not suitable candidates for teaching programming fundamentals to those not aspiring to be programming specialists.

My own experience, in even specialist post-graduate 'computer education' courses, is that there is insufficient time for those entering, without programming skills, to master a 'traditional' high-level language, to a sufficient degree, to be able to apply it to 'undertake applications programming'. Rather than using programming in such a language to 'exploit the educational applications of emerging fourth generation material', the approach should be reversed and the latter used as the more efficient vehicle for 'addressing the universal common fundamentals' [21] - with the option for the software development specialist to then undertake mastery of other languages.

The advantages of spreadsheet macro command languages for teacher developed software have been discussed in 3.2.

While not wishing to present them as a universal panacea, such languages provide a simple but effective vehicle for teaching programming fundamentals. They are provided in a range of 'standalone' and integrated spreadsheet packages and eminently satisfy Masterson's requirements for a programming language [22] i.e.'simplicity, power, compatibility and cognitive richness'.

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CIRCUIT SIMULATION PACKAGES IN PARA PROFESSIONAL ELECTRICAL ENGINEERING COURSES

by

James Wade

ABSTRACT

A range of microcomputer based circuit simulation software packages is now readily available. This paper compares, contrasts and evaluates the different features that are provided in these packages and discusses their role in the teaching of electrical/electronics engineering courses at para professional level.

The paper considers the impact of such simulations on both what is taught and how it is taught.

In the pre computer era the computational burden imposed major constraints on the problem solving process and significant amounts of energy were expended in obtaining solutions.

The paper outlines the curriculum reform needed to remove course components, made obsolete by computer based simulations, and discusses how the removal of much of the computational burden can be used to enable students to concentrate on often ignored aspects of problem formulation and interpretation of results.

The paper also discusses the use of interactive circuit simulations in implementing discovery learning strategies and in the development of problem solving and other cognitive strategies.

CIRCUIT SIMULATION PACKAGES IN PARA PROFESSIONAL ELECTRICAL ENGINEERING COURSES

by

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1. CURRICULUM AREA

This paper is concerned with the use of simulation software in paraprofessional electrical/electronics engineering courses.

The overall aim of such courses is to provide vocational educational programs for the upper middle level engineering technical workforce, specialising in electrical/electronics/computer technology. Under the current RATE classification system, such courses lead to awards at Associate Diploma level and are directed towards occupations such as engineering associate, technical officer etc.

However, it should be noted that these packages have application for other course levels and that much of their value is derived from their use as analysis and/or design tools in industry.

Engineering has been defined [1] as "the application of science and mathematics by which the properties of matter and the sources of energy in nature are made useful to mankind in structures, machines, products, systems and processes."

In electrical engineering, the application of science and mathematics is in the context of that 'physico-mathematical science' which Maritain [2] describes as a 'mathematisation of the sensible'.

Of necessity, the application of science and mathematics in engineering involves the use of simulation, in the sense of building and using models.

Electrical/electronic engineering, in particular, is largely concerned with invisible phenomena and relies heavily on mathematical models to both explain and design circuits and systems. The measurements used to quantify these phenomena have to be interpreted in the context of these models.

Thus, in engineering education, there has always been a primary role for 'theoretical or mathematical models' [3,p.74]. The advent of relatively cheap microcomputers has enabled the quicker and cheaper development of such models and made feasible their widespread use in classrooms.

2. TOPIC AREAS

The packages to be considered can be used across the wide range of subjects in which circuit/network/system analysis is a dominant component. This analysis is directed towards the development of skills that will enable paraprofessionals to undertake effective prototype evaluation, commissioning, calibration, maintenance and testing of equipment and systems. In achieving this objective, analytical techniques are typically incorporated into the curriculum in two broad ways.

2.1 In core subjects, which provide the foundation in basic circuit theory and analysis required by all electrical engineering paraprofessionals, irrespective of the areas of specialisation. In these subjects, circuit analysis is essentially being taught as an end in itself - abstracting from any specific application.

2.2 In more 'applied' subjects, in which circuit analysis is essentially a tool used to facilitate understanding through its application to models which are 'analogous theoretical representations' of specific aspects of technology [3,p.74].

3. ROLE OF COMPUTER BASED SIMULATIONS

3.1 General Considerations

Simulation software can be used to promote broad educational goals such as the following proposed by Woodhouse and McDougall [3,p.77].

- motivation for study
- learning of content
- mastery of skills
- development of concepts
- social interaction

Breuer and Hajovy [13] supply the following tabulation of 'educational uses of simulations'. This provides a good overview of the broad range of applications for the simulation packages being considered.

CONDITIONS OF INSTRUCTION	LEARNING ACTIVITIES	LEARNING OBJECTIVES
DEMONSTRATION	Observation of system changes	Knowledge of structures & dynamics of complex systems
TRAINING	Application of procedures	Internalisation of defined procedures
MODELLING	Variation of variables & interrelationships	Strategies of scientific encounter
ENVIRONMENTAL REPRESENTATION	Problem oriented decision making	Knowledge & skills refinement & development of heuristics

In terms of taxonomies, such as those of Kzenec et al.[7], these simulation packages have a place in both the 'knowledge generation - modeling' and 'knowledge dissemination - computer as a topic' categories; although the simpler software is more oriented to the former.

3.2 Cognitive Tools

Circuit simulation packages can function as cognitive tools in the sense used by Kozma [8]. That is:

'[They] are software programs that use the control capabilities of the computer to amplify, extend, or enhance human cognition. They are designed to aid users in task-relevant, cognitive components of a performance --- while leaving the performance open-ended and controlled by the learner.' 'Whereas other tutorials and simulations overtly engage in instruction, cognitive tools do not. ---- they are designed to function by short-circuiting task-relevant, cognitive resources that may be used for other perhaps higher level cognitive processes'.

3.3 Discovery Learning

When appropriately integrated, the programs can facilitate discovery-learning in the way outlined by Smith [9]

"Control is exercised by the learner who, using suitable computer procedures, is able to select from alternative routes through the material presented by the computer in pursuit of objectives, which, to the student, contain an element of discovery. In engineering, these procedures are naturally associated with computer modelling and simulation and their effectiveness is dependenent upon the quality of the support teaching."

"In a typical procedure in the discovery learning mode the student is offered interactive access to the principal parameters of a model of a system or process with the facility to change parametric values either singly or in combination and to observe the resulting responses. The appropriate computation is performed and the results are offered for display again interactively and ideally with the choice of comparative graphical presentation where appropriate".

This approach is similar to the experiential model of instruction favoured by Merrill [10] in which 'the student interacts directly with some behavioural representation of subject matter'. That is a representation 'which provides some controllable microworld with which the student can manipulate and observe'.

Circuit simulation packages provide the opportunity for 'experiential simulation' in the sense used by Drumm [11]. That is, they 'provide a series of experiences or procedures that would not normally be available to the student'. In particular, they enable students to observe the nature and effects of a range of significant transient phenomena, which in many cases are impossible to capture with basic laboratory equipment.

3.4 Problem Solving

Chapra and Canale [5,p.599] observe that:

"In the pre computer era, the computational burden had a limiting effect on the problem solving process and significant amounts of energy were expended in obtaining solutions. This had a number of effects. First, solution techniques were often simplified to make them feasible within the time constraints of a particular problem setting. Second, the number and extent of the computations were limited. Finally, because the techniques were so time consuming, other aspects of the problem solving process suffered."

"The computer's speed and memory greatly extend our analytical capabilities. By removing some of our computational burden, the computer allows us to place more emphasis on the creative aspects of problem formulation and interpretation of results."

They summarise the three phases of problem solving as follows with a) and b) representing the 'pre-computer' and 'computer' eras, respectively:

- FORMULATION

a) fundamental laws explained briefly

b) in-depth exposition of relationship of problem to fundamental laws

- SOLUTION

a) elaborate and often complicated method to make problem tractable
b) easy to use computer method

- INTERPRETATION

a) in-depth analysis limited by time consuming solution
b) ease of calculation allows holistic thoughts and intuition to develop; system sensitivity and behaviour can be studied.

4. CIRCUIT SIMULATION PACKAGES TO BE CONSIDERED

A wide range of microcomputer based analog and digital circuit simulation packages is now available.

To illustrate the salient characteristics of these, packages using the following three analog circuit simulation programs will be evaluated.

- BREADBOARD
- MICRO-CAP II
- PSPICE

The selection of these programs is not intended to imply the lack of suitability of other software for the defined curriculum and topic areas. These three have been chosen because they represent significantly different approaches to circuit simulation software, suitable for use in an educational context and also because the software is available for the 'IBM environment' used in Electrical Engineering courses in TAFE NSW. Collectively, the three programs demonstrate the main features available across the range of simulation software that is suitable for use in teaching and training.

Digital circuit simulation packages offer similar advantages in the teaching of digital electronics components; but will not be considered in this paper.

5. PACKAGE FEATURES AND APPLICATIONS

5.1 BREADBOARD

5.1.1 Main Features

As noted by Ciccarelli [16]:

"The program is interactive and provides a visual representation of a breadboard circuit. Modification of the circuit is easily accomplished with the on-screen editing feature of the program. This enables the student to obtain the new circuit parameters resulting from a change in value of a component. BREADBOARD provides the opportunity for the self-study of electrical circuit analysis."

5.1.2 Strengths

Of the three programs being considered, this is the easiest to use and quickest to learn. The program requires minimal computer 'literacy'. It closely simulates the placement of components in the laboratory breadboard context, with which students would be familiar. It is the only one of the three packages which has an explicitly instructional orientation. A range of documented student exercises is provided.

5.1.3 Limitations

The program has limited analytical features. In particular:

- there are no facilities for transient analysis
- there are no in-built device models for transistors, rectifiers etc.

5.1.4 Application

Ciccarelli [16] sees the main applications of BREADBOARD as follows:

'The exercises provide an orderly sequence of topics to reinforce the principles taught in the lecture room. Computer analysis of circuits allows the student to investigate many variations of circuit configurations quickly and easily, removing the tedium of solving by conventional methods. Laboratory experiment simulations can be readily effected.'

'BREADBOARD provides the opportunity for the self study of electrical circuit analysis.'

The graphing capabilities enable the effects of some parameter changes to be illustrated.

5.1.5 Support Documentation

The package comprises the software supplied with the book by Ciccarelli [16]. This adequate instructions about the operation of the program and provides a range of graded student exercises, which include statements of objectives, review of related theory and procedures to be followed.

5.2 MICRO-CAP II

5.2.1 Main Features

As noted in the documentation accompanying the software:

"MICRO-CAP II (CAP= 'circuit analysis program') is an interactive analog circuit design and analysis tool. It lets you sketch a circuit diagram on your video display and automatically creates a netlist suitable for simulation or analysis directly from the graphics diagram using device models that you define. MICRO-CAP II then lets you do an AC, DC, transient, or a Fourier analysis of waveforms generated by a transient analysis."

The software is available in a student version of a commercially available program, the main difference being in the number of nodes and components that can be included and the price.

MICRO-CAP III, featuring improved speed, capacity and new device models has recently been released.

5.2.2 Strengths

The ease of use is comparable to that of BREADBOARD. The ability to specify the circuit to be analysed by 'sketching' it on the screen has similar advantages to those outlined for BREADBOARD in 5.1.2.

The analytical facilities are far superior to those of BREADBOARD. The 'Analyse' option is directly accessed from a menu after a circuit has been 'drawn'. A further menu enables analysis parameters to be specified. The results of the analysis are displayed graphically, with a resolution dependent on the computer's graphics adapter.

A numeric output of selected node parameters can also be obtained and stored on disc for further evaluation.

A library of 'standard' components can be directly accessed from the main menu and component parameters can be readily changed.

5.2.3 Limitations

To utilise the full potential of this program, students need to individually interact with it 'on-line'. The extensive features of the program require much longer access than would be the case for BREADBOARD and this imposes additional hardware and software requirements. Thus, if used to its full potential, the classroom application of this program is relatively expensive.

If computer facilities are limited, other applications can be developed; whereby direct interaction with the program is restricted to the teacher and students are mainly concerned with interpretation of teacher generated graphical outputs.

5.2.4 Application

Applications of the type outlined in 5.1.4 are also possible with MICRO-CAP II; but enhanced analytical and display features extend the range of simulations which can be undertaken.

5.2.5 Support Documentation

The program is supplied with extensive documentation, including examples, for which the circuit files are also provided on disk.
The examples are not explicitly instructional and have to be adapted for use in the classroom. However, they do facilitate learning the features and operation of the program.

5.3 PSPICE

5.3.1 Main Features

The package been described consists of a student version of PSpice supplied with the book by Tuinenga [18]. In the preface, Tuinenga notes that:
"PSpice is one of the many commercial derivatives of SPICE and the first to be available on the IBM."
SPICE is an acronym for 'Simulation Program with Integrated Circuit Emphasis'.
Tuinenga [18] claims that 'SPICE is the de facto world standard for analog circuit simulation' and sees its main feature as:
"PSpice helps you simulate your electrical circuit designs before you build them. This lets you decide if changes are needed, without touching any hardware. PSpice also helps you check your design after you think it's complete. In short, PSpice is a simulated 'lab bench' on which you create test circuits and make measurements."
Although similar to the previous programs in its broad intent, PSpice is significantly different in that there is no on screen circuit diagram. Circuits to be analysed have to be specified by using a text editor to create an input file, with a .CIR extension, which lists circuit elements and their interconnections in a text format. PSpice interprets this 'program' and produces an output file, in ASCII format with an .OUT extension, which presents the results of the analysis in tabulated form. A separate program, PROBE, can be run from PSpice to provide a graphical display of the simulation outputs.

5.3.2 Strengths

With the exception of the on-screen circuit diagram, PSpice has all of the strengths outlined in 5.2.2. The graphical display obtained by running PROBE is superior, in that a 'cursor' facility is available to scan the display and provide high precision values of horizontal and vertical graph parameters, at any point on the display.
The need to specify the circuit via an external text file, although at the expense of an on-screen circuit diagram, does provide the advantage of enabling students to undertake a significant amount of preparatory work off-line, using any standard text editor. This minimises the number of classroom terminals required for PSpice based simulation activities.

The low cost of the package and the lack of copy restrictions on the accompanying student version of PSpice, makes student purchase feasible and thereby enables students to use PSpice outside of classrooms, on workplace and/or home computer facilities. Other texts (e.g. those specified in references 19 & 20) provide additional resource material to assist students in the use of this program.
The 'de facto standard' status of SPICE also confers an advantage. This status is evidenced

by the increasing inclusion of sections devoted to the use of SPICE/PSpice in new editions of commonly used Circuit Analysis & Electronics texts (e.g. ref. 21 & 22).

5.3.3 Limitations

There are two main limitations. The first is the lack of an on-screen circuit diagram and the need to 'read' the circuit being simulated from a text file.

The second limitation is that, unlike MICRO-CAP II, the circuit specification, analysis and display phases are not integrated within the one file and this limits user interaction.

Three quite separate files (i.e. circuit text file, PSpice itself and Probe) are required for a full PSpice analysis and this can result in a very cumbersome and tedious operation, unless automated by some appropriate batch file.

Batch files can be developed to overcome this problem. Using these in a MS-DOS 4.0 environment, with appropriate dialog boxes to pass parameters to the batch files, gives reasonable interactivity and avoids the delay and confusion that would otherwise result in moving between the text-editing, PSpice and Probe operations.

Similar functionality can be achieved with earlier DOS versions, by using commercially available 'commander' type of software.

5.3.4 Application

The full range of applications as outlined in general in 3 and in relation to MICRO-CAP II in 5.2.4 are possible for PSpice.

In addition to these, however, 'the de facto standard' status of Spice makes this package the most appropriate vehicle for implementing the curriculum changes in circuit analysis course components, as outlined in 6.3

5.3.5 Support Documentation

The Tuinenga text [18] includes examples, which are not explicitly[1] instructional and have to be adapted for use in the classroom. However, they do facilitate learning program features and operation. There is a range of other commercially available documentation to assist students in using the software (e.g see refs. 19 - 22).

5.4 SUMMARY

5.4.1 The latter two packages use software that was developed for industrial design/analysis applications and are therefore not 'overtly instructional'.

5.4.2 The packages can be used in implementing teaching/learning processes and activities of the type outlined in 3.

However, supplementary material has to be produced to enable these packages to be used effectively for activities directed towards discovery learning, problem solving.

5.4.3 The packages can be used as cognitive tools to reduce the computational burden in applications such as:

a) determination of circuit/system performance parameters

b) determination of component values required to produce specified performance parameters

c) observation of effects of changing component values and device parameters on circuit performance

d) supplementation of and/or preparation for laboratory work by providing a means of quickly predicting circuit behaviour

e) assistance to students in understanding and developing 'holistic approaches' to circuit performance, by providing concise tabulated and graphical information about the relationships between component values and performance parameters

f) assistance to teachers in development of resource materials

g) graphical demonstration of phenomena and in particular transients, which are otherwise not available to students

5.4.4 Some of the packages can be used to teach computer based analytical and design techniques.

6. CURRICULUM IMPLICATIONS

6.1 Influence of Computers

The increasing penetration of computer based technology and techniques has been the major cause of the rapid change which has characterised electrical engineering for some time. This has produced two types of impact on course design - it has affected both what is to be taught and how it is to be taught. This is particularly true of 'circuit analysis' topic areas, which are moving away from what Bugnolo described as 'the brute force application of the calculator to the equations'.

Instead of work-bench based breadboarding approaches, paraprofessionals are being increasingly required to use computer aided design (CAD) workstations for prototype evaluation and modification.

As Banzhaf [6] has noted:

'Circuit analysis done on a computer is a time-saver, tedium minimiser, imagination expander and excellent preparation for the type of work students will one day be performing in the industrial environment.'

In the preface to his manual on the use of the simulation software SPICE [19], he notes:

"In addition to learning classical methods of circuit analysis and design, they (i.e. engineering students) also need to learn to perform circuit analysis on computers in order to be prepared for industry. One added benefit of simulating circuit behaviour on a computer is that students can gain great insight into circuit behaviour which would be otherwise unattainable due to the sheer tedium of the mathematical operations necessary."

6.2 Integration with other Course Components

A number of writers have warned of the precautions that must be observed if simulations are to be used effectively in the classroom.

Bork [12] observes that:

"Since simulations resemble many research calculations, it is not surprising that faculties are easily convinced of their value. However, in observing classrooms, it quickly becomes apparent that students may not be as entranced as the faculty. Instructors must consider student attitudes if the material is to see successful classroom use."

He claims that:

"The major difficulty with simulations is that they often have no relationship to other course components. It is critical --- to integrate simulations into full modules or full courses.

Unless the simulation is part of the curriculum --- it is not likely to prove valuable for the class as a whole." The importance of integration is noted by others. Breuer and Hajovy [13] emphasise the inadequacy of simulations when they are isolated pieces of self-directed instruction. Kistler [14] notes the need for simulation software to move away from unguided discovery approaches.

6.3 Curriculum Reform

Circuit simulation software will not be used to its full potential if it merely supplements and/or reinforces the development of the 'by-hand paper and pencil' circuit analysis skills which have traditionally formed part of electrical engineering courses. In many cases, developing these skills to a reasonable degree of automaticity is no longer required for effective problem solving and only persists because of an incorrectly perceived need to continue with conventional forms of circuit calculations in written exams.

As has been noted in a related but different context [17] 'schools now spend too much time and money teaching ways to solve problems that can be solved more easily by computers'.

Major curriculum reform is needed to remove components made obsolescent by computer based simulations, thereby releasing course time to enable students to concentrate on often ignored aspects of problem formulation and interpretation of results.

Computer based analysis should be taught as an integral part of the core circuit theory/analysis curriculum, with a resultant removal of much of the 'traditional' detailed pen/paper/calculator based analysis.

Some of the benefits of this type of curriculum approach have been observed by Bogart [15]:

'The ability to predict experimental results, without performing time-consuming calculations, had a very positive effect in that students came to the laboratory with greater confidence and a better understanding of the experiment and its expected outcome. Furthermore, students were able to better recognise poor or incorrect results and to improve or repeat laboratory procedures to obtain better data.

The inclusion of SPICE/Pspice based analysis in recent editions of commonly used texts (as already noted in 5.3.2) is a recognition of the need to adopt this approach.

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STRATEGIES FOR ADULTS IN TECHNOLOGICAL TRAINING AND EDUCATION: REPORT OF RESEARCH FINDINGS

by

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ABSTRACT

CML's portability to the student's choice of study venue is beneficial for adult students. Our research shows students see this as a distinct advantage. That research led us to develop Takeaway interactive simulations linked with CML for use in those learning situations where visual representations can augment the learning process. Face to face lectures continue to be the major teaching strategy with CML and simulations providing instructional support, feedback and reporting. Future work will make exploratory learning materials available on a Takeaway basis.

How can we use information technology to increase available study hours for part time students in Information Technology? Can we use the technology to provide learning materials which are not merely computer driven replicas of the *book paradigm*? These are some of the questions which research at the Faculty of Information Technology (FIT), Queensland University of Technology (QUT), addressed during 1990. The project was funded by a Department of Employment, Education and Training (DEET) Reserve Fund Grant.

Part time students are the same people as full time workers. They are mature adults with very busy lives. Most have family obligations in addition to their paid employment. Time is their most precious resource and scheduling their time to enable them to accomplish all the obligations that study, work and a family impose is their most frustrating task. Where the student is working in a computer field, this can be exacerbated by the scarcity of computer professionals in Australia which makes overtime work the only alternative in many organisations.

BACKGROUND TO THE PROJECT

The Computer Managed Learning (CML)[1] system from Computer Based Testing Services (CBTS) was first used in the Faculty of Information Technology in 1988. The CML system at Queensland University of Technology can deliver tutorial material to a large number of students at 24 hours a day on a seven day a week basis.

In Autumn 1988, the Faculty set up CML in the first subject, an introductory computer subject run for students in the Faculty of Business. The introduction was a literal trial for all involved. More than 220 students used the system that semester.

However, based on what we learned the first semester, we improved the question banks and the operation of CML for this subject. We added a large question bank from the adopted text. This was instrumental in improving the students' usage of the text. Over two-hundred students used the system for that same subject in the second semester. In the final exam that semester, student performance was substantially improved; failures decreased by 9%.

By Autumn semester 1989, three subjects were utilising CML, with over 500 students in that and the following semesters. In the second semester an additional subject ran a voluntary CML trial which was taken up by eleven students out of nearly 300. This was an enlightening outcome. The participation rate is nearly unanimous where the CML exercises are included as part of assessment, even though CML exercises usually account for less than 10% of the subject assessment and are not compulsory. In 1990, additional subjects were brought onto CML with a total of 2500 students enrolled during the year.

In addition to the Faculty's CML facility, the Gardens Point Campus of the QUT has an expanding Computer Based Education (CBE) facility which delivers interactive drill and practice and tutorials on a network of PC-Clones. This facility is available to all faculties and is housed in the campus library. Students can use the facility only when the library is open. However bookings for a terminal can be made in advance. Courseware developed for this facility uses the Author system. Our survey revealed that over two-thirds of our respondents had used the CBE. Experience was higher among the full time students (91% compared with 67%), a reflection of their participation in a library course designed to familiarise our incoming students with the facilities of a University library.

FEEDBACK FROM STUDENTS

In early 1990 we conducted four discussion groups followed by a telephone survey of over 150 students and former students. Our aim was to

1. determine the types of problems part time students have with their studies,
2. find out what motivates them to continue in their studies,
3. ask their opinion about the various forms of computer delivered instructional materials with which they had experience.

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[1] Computer Based Testing Services, Calgary, Alberta, Canada, marketed two products through 1990 -- LMS and CML. They have rationalised their product line and now market both the products as LMS rather than CML.

Aside from a control group of 30 students, all students had taken subjects which used the FIT CML system as part of their instruction. The telephone sample was weighted toward part time students due to our project interest in the problems of part time students and their means of coping with them.

All subjects in the Faculty are conducted on the traditional University lines of face to face, on campus lectures, required texts with assigned readings and tutorial sessions. CML exercises complement the traditional materials and provide continuing feedback to the student. All students who were included in the survey group would have used CML in subjects with lecture populations of between 150 and 350.

Our part time students had spent an average of 3.2 years studying for their degree when we interviewed them and estimated another 3 years to finish which meant they were on schedule. Full time students had studied an average of 2.1 years and estimated another 2 years on average, a year longer than the course schedule.

MOTIVATION TO FINISH A DEGREE. We looked at what kept students progressing toward their degrees. Earlier work by Tinto (1975, 1982) and by Kember (1989) showed dropout was influenced by student goal and social commitments as well as academic success. Tinto's model was developed for the US residential university condition while Kember was primarily interested in problems of distance education students. QUT is a non-residential, urban campus, but many of the same conditions apply.

We found that our discussion groups spontaneously cited many extrinsic and intrinsic goal and social motivators as contributing to their degree completion. From the discussion, we compiled a summary list and asked each of the students in the telephone sample which of the reasons had a bearing on their personal study.

Extrinsic motivators relating to employment showed up in three areas. The relevance of University degree to their *job prospects* had a strong bearing on the majority of students. Part time students, already in the workforce, were somewhat less likely to cite the job prospects as a motivator than fulltimers. They were also less likely to cite *better job performance* as a motivator. However, part time students were nearly three times as likely to keep studying because they *want to change careers*.

Intrinsic motivators to *finish what they started* and simply *learning for the joy of it* ranked highly with two-thirds or more of the part time students with a slightly lower rating among the full time students.

Reasons continue studying	Part time %	Full time %
Better Job Prospects	78	93
Perform Better in my Job	58	64
Want to Change Careers	41	14
Finish What I Started	69	53
I Enjoy Learning	65	69
Family Moral Support	44	55
Family Financial Support	12	31
Company Moral Support	26	5
Company Financial Support	24	3

Table 1. Motivators for Continuation of Studies

Social commitments such as *Family moral* (55%) and *financial* (31%) support was important in keeping the full time students studying while *company moral* and *financial* support was important to about a quarter of the part time students.

INTERACTIVE TECHNOLOGIES — SOME PROS AND CONS

Interactive technologies, a new term for Computer Assisted Learning (CAL), are the glamour end of Information Technology and Education. Some subject matter lends itself to this technology — graphic representations can replace thousands of words and rapidly convey concepts and information to the student. The technique is also useful for it's first application, drill and practice, where training is required for a large number of people to achieve basic levels of *fluency* with key terms or actions.

DELIVERY. However, the down side is the tyranny of location. Tying the student to a computer limits the range of materials which can be dealt with in a session and introduces time stresses. Another student waiting to take up the seat and the cursor imperatively blinking encourage the ascendancy of speed of completion over depth of exploration. If we add to this the constraint of availability from a small number of locations which are not open around the clock, we place serious limitations on the part time student.

In our discussion groups, certain problems and benefits were identified in connection with computer based educational materials. We used these statements to determine the extent to which the opinions brought out in the groups represented the broader student population.

Only those students who had experienced CML or CBE were asked the extent to which they agreed or disagreed with the statements relevant to those experiences. Because we used very few opinion questions, we elected not to actively reverse scales within the sets. In the interest of presenting both types of computer based teaching systems in the same manner, we kept the scales consistent between them. Wording used was derived from the group discussions held earlier.

Eighty seven students in our sample had experienced CML at QUT and 121 had used the CBE facility. For each student, we read out the appropriate set(s) of statements which summarised the major opinions arising from the group discussions and asked the students whether they agreed or disagreed with the statement. We further asked them to define the strength of their opinion by asking *would that be moderately (dis)agree or strongly (dis)agree?* In this way, we were able to encourage the students to express an opinion.

	Weighted Agreement Ratio
Related to CML	All Students
Like to take question printout home	2.5
Helps deal with large classes	2.0
Encourages keeping up with subject	1.8
Useful for Revision	1.7
24 Hour access is useful	1.7
Helps learn through quicker feedback	1.5
Helped me get a better mark	0.5
Identifies misunderstanding or lack of knowledge	0.1
Disadvantages part-time students	-1.5

Table 2. Opinions of Computer Managed Learning

We assigned arbitrary weights to their response using the following five levels.

+4	Strongly agree
+2	Moderately Agree
0	Neutral
-2	Mildly disagree
-4	Strongly disagree

This allows us to summarise their opinions into the Weighted Agreement Ratio used in Tables 2 and 3.

In both groups, the highest ranking opinion supports the use of takeaway materials for further study. The CML system was seen to be the least disadvantageous for part time students.

	Weighted Agreement Ratio
Related to CBE	All Students
Prefer printed copy of questions/answers	3.1
Only use it for assigned exercises	2.3
Encourages keeping up with subject	2.0
Useful for revision	1.8
Usually get a terminal when I want	1.3
Disadvantages part-time students	-0.4

Table 3. Opinions of Computer Based Education

University students have been selected through the education system to be proficient at assimilating information from printed materials. Using computers as page turners can be more frustrating than enlightening to these students. This is particularly the case with the part time student who considers time their most precious resource. Where the computer based materials can be used from a variety of locations, particularly from home, they become more practical. Otherwise, the student may well prefer a portable book. Takeaway computer based courseware allows students their choice of computer and location. This might be at home, at work or at a preferred laboratory on one of our campuses.

Laptop based delivery mechanisms are another alternative and another facet of our project explored their use. Laptops can help by allowing the student to escape into the stacks of the library, the laboratories, to an observation site or to their own personal study space. The portability advantage of the laptop should be remembered when looking for the most effective ways to meeting instructional objectives. We already see these used for note taking at lectures and for laboratory session. In future we expect that more of our students will use laptops.

DEVELOPMENT. The problems with developing CAL resources have been well documented in the literature. Even with good authoring languages, development time is usually estimated as a ratio of 150 to 200 hours per hour of delivered courseware. Additionally, it is difficult to change or update courseware which is embedded in the authoring system because a one change may impact on other decision paths. There is, of course, a need for extensive testing of decision paths in the system and some authoring systems are giving the author tools to assure more thorough testing. A significant problem at a University is the issue of portability across platforms. There are large variations in the available computers in University situations; we envy industry their control in this area. When the possibility of modem access is added to this, few packages handle the diversity.

Record keeping and feedback for both student and lecturer are also important. We find authoring package are not commonly utilising relational database technology. This limits their reporting and information gathering capabilities to those provided in the original package or custom written for the client.

CML — COST EFFECTIVE COMPUTER DELIVERED TAKEAWAY COURSEWARE

In the area of Information Technology and industry, however, basic and continuing education needs are more economically met with less labour intensive methods of delivery than CAL. The Royal Navy (Mizen, Marley and Moore,1990) evaluated various interactive methodologies and found that only Simulations and Drill-and-practice were economically effective when delivered by computer. Face to face and print based materials were more effective than interactive computer based Tutorials.

At the Faculty of Information Technology, we have arrived at a similar conclusion for our subjects. We have identified two areas where information technology can effectively meet our courseware needs:

1. Conveying basic terminology and concepts to the student. This includes the delivery of diversified examples of a concepts which cannot be economically covered by face-to-face methods.
2. Illustrating advanced or difficult concepts where graphics or animation can contribute to more rapid understanding.

EFFICIENCY OF DEVELOPMENT. Computer Managed Learning as used in the FIT has the advantage of providing a portable learning resource in an efficient manner. Learning objectives can be reinforced by the lecturer through use of proven directed questions which lead the student to read assigned texts, research materials in the library, observe the interactions of humans with computers, explore the nuances of database queries or any of a variety of tasks which do not require their presence at a computer terminal. CML can also be used to capture the outcome of the students' experiments with particular software in one of our computer laboratories.

Lecturers can quickly draw on available resources to populate the questionbanks and questions are easily tested. As each question can stand on its own, complex path through the materials don't exist. The students are issued a printed quiz which is randomly drawn from large sets of questions which cover relevant learning objectives. The lecturer's previous experience can be used to distribute the emphasis among the sets of objectives represented in the questionbanks. Feedback reports provide actionable information on the degree to which their strategies are correct.

Our students spend large amounts of time at a computer terminal, but we prefer to have them spend this in active learning about a programming language, improving their understanding of human-computer interfaces, designing databases, testing their understanding of database queries and the like.

INTEGRATION OF INSTRUCTIONAL MEDIA. We do use some computer aided instruction with novice computer users. We find *PC-Tutorial*, a shareware product, is quite good with those who are not microcomputer literate. They have a goal — finish at least one of the tutorials — and do not realise they are learning a lot about operating systems, system commands, the keyboard and becoming generally at ease with the computer. We have augmented this system with CML delivered questions to focus the student's attention on some of the key points in the tutorial. Use of available, short, portable instructional materials in conjunction with the CML questions is both effective and efficient.

Our development effort for interactive materials has been focused on simulations and demonstrations which illustrate advanced or difficult concepts where graphics or animation can contribute to more rapid understanding. See the paper by Knight, et al. (1991) for more detailed coverage of these activities.

THE FUTURE

Over the next two to four years we expect the computer platform to evolve dramatically. We expect to see MicroSoft Windows 3 become common on university and student machines. We feel they will be based on the Intel 80386 or 80486 microprocessors and will have colour monitors supporting at least 1000 pixels per row. Internal memories will be much larger than today's standard 640 Kilobytes (Kb), probably in the order to 4 to 8 Megabytes (Mb).

Storage devices will also increase in capacity. We have been using removable, high density storage media such as 20 Mb floppy drives which cost just $80, and 40 Mb removable hard drives. The 620 Mb magneto-optical rewritable disks and CD-ROM technologies are also available and prices are dropping. Their quality and capacity will allow us to provide complete course materials utilising interactive exploratory systems like hypertext and even multimedia for students off campus.

Industry predictions say a CD-ROM drive and a video compression-decompression coprocessor will be included in the next generation of desktop computers. Late in 1989 Intel announced the Digital Video Interactive (DVI) chip-set to enable full moving video images to be compressed to a useful size. With this technology we will be able to utilise high quality moving images in conjunction with instructional materials and update them without the high cost of remaking video disks.

Within one to two years, this courseware will be economically viable *off-campus* — in the homes of part time students. Development of techniques for efficient utilisation of this technological breakthrough will facilitate their transfer to other educational uses such as industrial training and primary and secondary education.

We expect to link these capabilities with a CML system which provides central access and recording. We also look to object oriented design to provide authoring systems which produce maintainable courseware.

SUMMARY

CML's portability to the student's choice of study venue is beneficial for adult students. Our research shows this is seen as a distinct advantage by part time students studying Information Technology subjects. That research led us to develop Takeaway interactive simulations linked with CML for use in those learning situations where visual representations can augment the learning process. Further work will lead to making exploratory learning materials available on a Takeaway basis.

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TRAINING EDUCATORS AND EDUCATING TRAINERS: A JOINT INDUSTRY/UNIVERSITY PILOT COURSE ON DESIGNING EDUCATIONAL SOFTWARE

by

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Abstract:

Funding was obtained from the Victorian Education Foundation in 1989 to develop a pilot elective in 1990 within the Graduate Diploma of Computer Education. Titled "Designing Educational Software", the course takes advantage of new authoring tools and multimedia facilities to introduce teachers to the world of Computer Based Training in industry. CBT is a career path for teachers that has not yet been exploited and at the same time, the CBT industry reports skills shortages. The course has been designed in co-operation with the CBT industry in Victoria.

In 1991, the pilot will continue and will be made available for enrolments from industry. The ratio of teachers to industry trainers in 1991 will be approximately 4:1 but will increase to 1:1 in 1992.

A second aim of the course is to expose industry trainers to the educational philosophies behind school level software. From the interaction of school teachers and industry trainers, we will attempt to develop broader models of CBT than the ones currently embraced by the training industry. Likewise we would hope that the development of school software would benefit from exposure to the more sophisticated facilities available in industry.

The paper describes the evaluation of the pilot course in 1990 and comments on plans for 1991, including co-operation with other educational institutions.

Background:

The Victorian Education Foundation (VEF) was established by the Victorian government and is funded by industry from 0.1% of their pay roll tax. The scheme is voluntary and is designed to enable industry to create training and education solutions more in line with their needs. VEF funding enables innovative training to get off the ground quickly and fills a gap until the training is integrated into the normal offerings of TAFEs and universities.

Computer Based Training is a rapidly growing sector of the training industry. Many major companies have now passed the exploratory stages typical of early pilot CBT projects and have integrated CBT into their training departments. In addition to people employed within company training departments, a number of CBT companies have been spawned, specialising in the development of CBT under contract. Several CBT authoring tools have been developed in Australia and are widely used in addition to the well-known imported authoring packages. Victoria has an active CBT association: the Computer Based Training Association of Victoria (CBTAV) which meets regularly and publishes a newsletter.

There are some barriers to the acceptance of CBT including cost of implementation and development, cost of IT equipment, opposition to change, and lack of experienced, innovative CBT developers. All CBT companies and organisations using CBT acknowledge a skills shortage in the area of CBT authors. It requires an interesting and rare mix of skills: a knowledge of instructional design, ability to program, understanding of educational theory, an eye for screen design or user interface, and familiarity with new hardware and software advances that impact on learning. Generally people employed as CBT authors have to be trained/retrained by their employer. Generally they come from three areas: the schools or training area with little or no experience of computing or vice versa from the computing area with little practical understanding of education and training concerns or from the knowledge domain of the CBT to be developed, for example bank teller, again with little understanding of computing applied to education.

The Institute of Education at the University of Melbourne submitted a proposal to the VEF to address this skills shortage. We were granted an Education Innovation Award, Applied Research Program: Information Technology.

The Institute of Education was Melbourne CAE prior to amalgamation with the University of Melbourne. It is one of Australia's largest teacher training institutions. The Institute offers a Graduate Diploma in Computer Education, a two year part-time diploma for teachers which can qualify them for Ministry of Education tagging as Computer Science teacher. Increasingly however the diploma has also attracted teachers from all subject disciplines, primary and secondary, interested in applying computing across the curriculum. On average the new intake is 60 - 75 teachers per year. With such a large intake, the diploma is able to offer a number of electives in addition to its core units.

The Graduate Diploma of Computer Education (GDCE) does not currently include an elective on Designing Educational Software. The last time that the course was re-designed it was common belief that teachers should not be designing software. In earlier years of the course some teachers chose to develop educational software as their major project using such tools such as PILOT or programming in BASIC. However the GDCE project supervisors generally discourage most teachers from software development as it was found that the time and effort required to develop the software far exceeded the time available in the year.

However the tools have arrived that now make this field more accessible to teachers. The Macintosh is used widely throughout the university and GDCE students are now being introduced to Hypercard as a core component of the course, along with Logowriter, a successor to Logo. The teachers' first projects with Logowriter and Hypercard automatically veer towards "software that teaches". It is the knowledge domain they know best. The development of software that teaches, helps us think more clearly and concretely about the nature of teaching and learning. The GDCE is a diploma in computer EDUCATION not a diploma in computing.

The GDCE is currently being re-designed for implementation in 1992. The pilot course funded by the VEF has helped to ensure that this aspect of educational computing becomes an elective in the 1992 new GDCE. It has raised awareness of the previous gap. Each year one or two GDCE graduates leave teaching for the CBT or training industry even though the diploma has not formally trained them for this. In future it will be part of the curriculum to raise teachers' awareness of alternative career paths.

In addition to new tools making it easier to develop educational software, there have been rapid developments in the area of multimedia. The new tools automatically encompass multimedia. Part of the resurgence of interest in educational software can be attributed to the excitement caused by the demonstrated potential of multimedia software. The University of Melbourne has established in 1990 an Interactive Multimedia Laboratory. Its main function is to professionally develop academic staff of the university in creating multimedia presentations and courseware. Originally it was envisaged that the 1990 Pilot Course for teachers would focus on developing multimedia software, however the facilities were not available in time for the start of the course.

Description of 1990 Pilot Course:

In 1990, the pilot course was run only for current students of the GDCE. No fee paying industry CBT authors were enrolled until the course had been developed and trialled. The 1990 GDCE students were used as "guinea pigs". It was run as part of an existing elective called "General Purpose Software Tools". The rationale was that authoring languages can be described as general purpose software tools.

Instead of the 20 students normally enrolled for an elective, we allowed 40 to enrol and ran two streams of the elective, Stream 2 being "Designing Educational Software". We only allowed second year students to apply for Stream 2, as we wanted them to have introductory programming as a pre-requisite.

In 1990 15 enrolled in Stream 2. To satisfy the accreditation requirements of General Purpose Software Tools, there were some lectures common to both streams and one common assignment. The assessment consisted of three minor assigments and one major assignment.

The elective ran over sixteen weeks, one and a half hours per night, one night per week. In addition there were five weeks holiday during the course which enabled teachers to spend time on developing their major project. The course included two guest lectures from the CBT industry and a visit to a major bank's training centre was scheduled. The visit was unfortunately cancelled at the last moment.

We used "meta-CBT" as a teaching strategy in the course: CBT to learn about CBT. We used Micro-energy's "Creating CBT: a Developer's Guide". Microenergy was one of the other four winners of a VEF Education Innovation Award in 1989. Their award was for creating a CBT developer's guide. The guide consists of a book and 3 disks. The disks contains examples of CBT illustrative of the points they make in the book. In return for access to the draft guide, the teachers in the elective evaluated Micro-energy's package. Three weeks were allocated to this activity.

The last half of the course was spent working on the major project. The major assignment was a team project to design and develop a CBT unit using the authoring tool, Author. Author is a Victorian product by Microcraft. It has many users in the Victorian CBT industry as well as elsewhere in Australia and overseas. The assignment was a team project not only due to the constraints of time but because most software development in the "real world" is a team development and teachers, used to the autonomy of their own classrooms, in general are unused to working in teams.

Class contact time was given over to the team projects instead of lectures, for a number of reasons. We were using IBM PS/2 machines with VGA colour to give the teachers access to effects they may not have seen on school-level machines. Normally teachers in the GDCE spend many hours in their own time on GDCE projects, however they did not have access to these machines outside the university. In addition our site licence for the authoring language did not extend to a home licence and authoring languages are not found in schools. Hence their only access to the machines, and to the other teachers in their teams, was confined to class time. Although we were giving teachers experience of things not normally encountered in schools, the decisions we made restricted their progress with their projects. This is a problem we need to resolve in the 1991 course.

On the last night of the course, members of the CBT industry were invited to attend to see the teachers' presentations of their team projects. Each project was evaluated by all in attendance using a proforma and copies of the completed evaluations were posted to the teachers afterwards.

The minor assignments included a written evaluation of Microenergy's "Creating CBT" and a literature review. The bibliography is attached and includes of course the proceedings of WCCE 90, the Fifth World Conference on Computers in Education held in Sydney in July 1990. Some of the students in this elective attended CBT 90, the mini-conference run in conjunction with WCCE 90. They commented on the technical sophistication of the applications demonstrated but felt that many lacked a sound underlying educational philosophy, or at least the philosophy was not in keeping with the ones held by teachers. This is a theme that I intend to address in more depth as the elective increases its enrolments of industry authors in 1991 and 1992.

Evaluation of 1990 Pilot Course:

An evaluation form was distributed and returned by 12 of the 15 students. The following are excerpts from the evaluation.

Why did you enrol in the course?

"actually learning about something which is used in industry interested me"; "to ascertain use of CBT languages in schools"; "had to do something and this topic seemed to have some purpose to it"; "I thought it would be useful if I needed a job in industry and because I thought it would be interesting"

On a scale of 1 to 5 please rate you feelings:

1 strongly negative 2 negative 3 no comment 4 positive 5 strongly positive

The Course as a whole:	*Average Rating:*
- your enjoyment of the course as a whole	4.3
- the usefulness of the course to you	4.0
- the assessment as a whole	3.5
- content of the course	4.1
- structure of the course	3.5
- the course lecturer	4.2
- your desire to continue work in this area	4.4

The Components of the Course:

- Microenergy's "Designing CBT" - book	3.6
- Microenergy's "Designing CBT - the disks	3.3
- evaluating Microenergy's "Designing CBT"	3.3
- learning "Author"	4.6
- the literature review	2.9

- guest speaker 1 - (CBT Design)	4.4
- guest speaker 2 - (Author)	4.3

What did you like best about the course?

"working with Author"; "working in teams"; "seeing other teams' presentations"; "finishing the CBT project and seeing it work"

What did you not like about the course?

"amount of work involved"; "literature review"; "not enough time/support when writing our CBT"; "IBM's weren't available all the time"; "software not lent out - big minus"; "missing out on the industry visit"; "problems with the network"

Would you be interested in working in the CBT industry - full or part-time?

Fulltime 3; Part-time 3; Either 3; Maybe 2; No 0

Future Developments:

In 1991 we propose to iron out the problems encountered in the 1990 course and allow enrolments of 5 fee paying students from industry. It is envisaged that the course will run in its own right without VEF funding in 1992. There exists the possibility of running it twice per year in 1992 as it would be self-funding due to the percentage of industry authors to teachers being 50/50 by that time.

In coming years, the course will include much more emphasis on Interactive Multimedia. In 1991, I would like to provide the students with a choice of authoring systems and envisage each team using a different combination of machines, peripherals and authoring languages, for example Macintosh with Authorware Professional, Hypercard with an existing videodisc to be re-authored, Amiga with Amigavision etc. An important aspect of the course for the teachers could then be a comparative evaluation of the different systems. However this requires the lecturer to maintain a high level of skills across a range of rapidly changing machines and tools. An alternative, or enhancement, could be to utilise the resources of a number of specialist consultants for the course to cover each area. This route has funding implications which have yet to be resolved.

Another area that we are keen to explore in the coming year is that of rationalisation between institutions, not just in Victoria but possibly Australia-wide. In Victoria there are two other institutions with courses that touch on the area of CBT. Each of the courses is different in content, structure and level so a choice is available to prospective students. However thought needs to be given to articulation issues.

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KNOWLEDGE STABILITY IN AN *ITS* BASED ON A COGNITIVE MODEL

by

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and
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ABSTRACT

Student modelling is one of the most important issues in intelligent tutoring systems (ITS). Recently, a number of models have been proposed. Three well-known models are the Overlay Model, the Bug Model and the Process Model. In the course of the research described in this paper, models of student performance on language tasks were developed and applied to the operation of an ITS designed to monitor and improve student performance. The domain of the research is English that is taught in junior high or senior high school. Observation of student performance led to the development of a model of performance as being composed of three sub-processes, as follows:

1. Process of Task Interpretation
2. Process of Background knowledge Selection
3. Process of Background knowledge Execution

From observation of student behaviour in the course of each of these 3 sub processes, there appeared to be 4 discrete states of student background knowledge. This paper describes four states which comprise our Stability Model of student knowledge, as follows:

a) Incorrect hypothetical knowledge: incorrect hypothetical knowledge was stabilised instead of correct knowledge
b) Absent knowledge: correct knowledge was not stabilised
c) Correct hypothetical knowledge: students had the correct knowledge, but failed to apply it
d) Stable knowledge: correct knowledge was stabilised.

We think correct background knowledge is not permanent at the outset but will become stable as time passes. The Stability Model describes this transformation. By using the Stability Model, the ITS can assess the degree of knowledge stabilization.

KNOWLEDGE STABILITY IN AN *ITS* BASED ON A COGNITIVE MODEL

by

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1 INTRODUCTION

The construction of student models has been considered as one of the fundamental themes of ITS[1][2][3] because they are responsible for the implementation of high-level personal instruction. So far, the Overlay Model, the Bug Model and the Perturbation Model have been proposed. They construct a student model based on his/her superficial behavior. A process modeling of students' misconceptions was proposed by Matz[1]. However, since the aim of that system is to explain misconceptions, studies of applications of such a model to the construction of a student model and of differences of student's behavior due to knowledge stabilization were not reported. The aim of this paper is to provide a student model that describes the problem solving processes and knowledge stabilization processes.

This paper selects several problem solving processes and related misconceptions and proposes a knowledge stabilizing model suitable to deal with them. In this paper, knowledge stabilization is taken to mean the correct acquisition of problem solving processes as well as the enhancement of their application. The stabilization model assumes that the student already possesses inherent or acquired problem solving processes, although he or she is not yet proficient in their application. It proceeds to support the student until he or she masters the application of such processes.

2 AN ITS FOR ENGLISH TRANSFORMATION EXERCISES

2.1 System's Objective

The objective of the present system is to provide support to the stabilization of problem solving knowledge by using English transformation exercises .

We believe that the student must follow certain steps in order to correctly apply problem solving knowledge. Since this system's teaching strategies take into consideration the stability level of the student's knowledge, we have opted for a student model that allows the representation of stability levels. We have introduced the four levels described below. Their appropriateness is described in section 4 :

1) Stable Knowledge,
2) Correct Hypothetical Knowledge,
3) Absent knowledge,
4) Incorrect Hypothetical Knowledge.

Unstable knowledge is diagnosed according to the following rules :

D1) If the cause of the error is due to missing knowledge, we define it as Absent Knowledge,
D2) If the cause of the error is due to incorrect knowledge, we define it as Incorrect Hypothetical Knowledge,
D3) If the cause of the error is due to the misapplication of the correct knowledge, we define it as Correct Hypothetical Knowledge.

This system determines which of the following strategies should be used based on the stability level :

E1) Absent Knowledge is taught directly (tutoring),
E2) Incorrect Hypothetical Knowledge is taught indirectly (Coaching),
E3) Correct Hypothetical Knowledge is dealt with by providing the student with problems that present the highest difficulty level he/she is able to solve by applying that particular piece of knowledge.

2.2 System's Structure

Figure 1 describes the system's structure. The system can be divided into tutoring modules and student's diagnosis modules according to the purpose they serve.

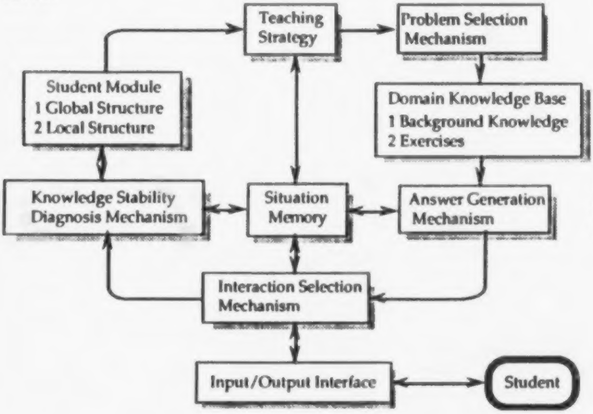

Teaching Strategy
Problem Selection Mechanism
Student Module
1 Global Structure
2 Local Structure
Domain Knowledge Base
1 Background Knowledge
2 Exercises
Knowledge Stability Diagnosis Mechanism
Situation Memory
Answer Generation Mechanism
Interaction Selection Mechanism
Input/Output Interface
Student

Figure 1
System
Configuration.

1) Student's diagnosis modules :
 Knowledge Stability Diagnosis Mechanism and Student Module.
2) Tutoring modules :
 Teaching Strategies Module, Problem Selection Mechanism, Domain Knowledge Base, Answer generation Mechanism.
3) Common Elements :
 Context Memory, Interaction Selection Mechanism, Input/Output Interface.

The Knowledge Stability Diagnosis Mechanism analyses the student's reply and determines the stability level according to rules D1 through D3. The diagnosis reached by the Knowledge Stability Mechanism is stored in the Student Module.

The Teaching Strategies Module analyses the information contained in the Student Module and determines which teaching strategy should be used. If the error is diagnosed to be due to an incomplete mastery of a certain piece of knowledge, the Problem Selection Mechanism is activated and a problem suitable to the student's level is selected. The Domain Knowledge Base sorts the problems to be proposed to the student according to their characteristics. The Student Module is based on a template of the Domain Knowledge Base. The Problem Selection Mechanism is therefore able to select the problem more suitable to a particular student by analyzing both the Domain Knowledge Base and the Student Module. Furthermore, this system determines the in/ correctness of a student's answer by comparing it with the answer provided by the Answer generation Mechanism.

The Interaction Mechanism interfaces with the user through the Input/Output Interface. The Input/Output Interface matches the student's input against a provide set of keywords and is therefore able to recognize the intention of the student's input. The Interaction Management Mechanism proceeds the session based on the student's intention.

3 STRUCTURE OF THE DOMAIN KNOWLEDGE BASE

This section describes the domain knowledge base and its structure. The structure selection for the knowledge was based on two standpoints :

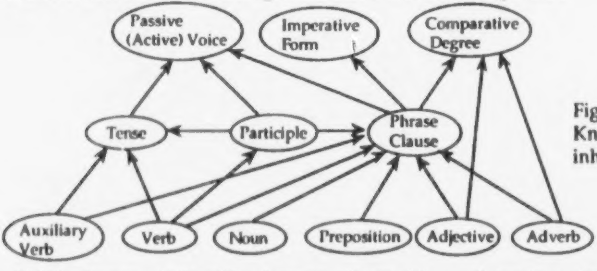


Figure 2 Knowledge inheritance.

1) Inheritance relationships between the problem solving knowledge included in different sections of the knowledge base (e.g., Comparative Transformation, Passive

Transformation.).

2) The classification of problems within one section according to their relative difficulty.

3.1 Structure Selection from the global standpoint

3.1.1 Global Classification

We have extracted the knowledge needed to solve problems in each section and analyzed how each piece of knowledge relates to one another. The result is represented in figure 2. As can be seen, to solve a Passive transformation exercise, depending on the problem, knowledge of Imperative Sentences and Relative Pronouns may be necessary.

3.1.2 Structure representation

Problem solving processes are represented basically via production rules. Inheritance relationships are represented by adding inherited and inheritable information to each rule.

(1) Exercise format
  1 Word Transformation : Fill the blank by compa[illegible]es
      old -> ( )
  2 Word Transformation : Change the style of the word
      He was (old) than his father.
  3 Translation : Translate the next sentence to Japanese
      Which is older, you or your brother?
  4 Selection of the word : Fill the suitable word in the next blank
      I'm fifteen years old. You are seventeen and
      Hanako is ten. You are ( ) than I.
  5 Translation : Translate the next sentence to English by using comparative sentence
      生徒の中では彼が一番年上である

(2) By the difficulty of transformation of adjective and adverb
  1 faster -> faster, fastest
      (one syllable : Regular transformation which adds -er, -est)
  2 fine -> finer, finest
      (Ending by 'e' : Regular transformation which adds -r, -st)
  3 big -> bigger, biggest
      (Short vowel + consonant :
      Regular transformation which doubles consonants and adds -er, -est)
  4 beautiful -> more beautiful, most beautiful
      (Words which have more than three syllables :
      Regular transformation which adds more-, most-)
  5 kindly -> more kindly, most kindly
      (Words which have two syllables and ending by 'ly' :
      Regular transformation which adds more-, most-)
  6 profound -> profounder, profoundest
      (Words which stress the second syllable :
      Regular transformation which adds -er, -est)
  7 ill -> worse, worst
      (Irregular transformation of the particular word)

(3) By the difficulty of the structure of the sentence
  1 Simple sentence
  2 Compound sentence
  3 Complex sentence

Figure 3 Local Difficulty.

3.2 Structure selection from the local standpoint

We have stored each problem within one section according to its relative difficulty in relationship to each other. A specific example for the Comparative section can be in figure 3. Each problem has been stored according to three axes :

1) the difficulty of the adjectives and adverbs used,
2) the difficulty of the sentence structure,
3) the difficulty of the problem's style.

According to the section the problem belongs to, the student's feeling of difficulty varies. Therefore, the axis or axes used in each section may vary accordingly.

3.2.2 Structure representation

Problems are represented as frames. In order to allow each sentence to be used in different problems, necessary knowledge is represented as slots in each frame.

4 ANALYSIS OF THE PROBLEM SOLVING PROCESS

In this section, we will analyze the problem solving process the student utilizes to solve English Transformation. Exercises from a cognitive standpoint.

We will specifically deal with the possible mistakes the student may commit in each subprocesses. Based on them, we shall propose a stability level model for the knowledge involved in problem solving.

4.1 English Transformation Problem Solving Processes

We assume that the problem solving process is subdivided into three subprosesses. Figure 4 shows the relationship between theses subprocesses.

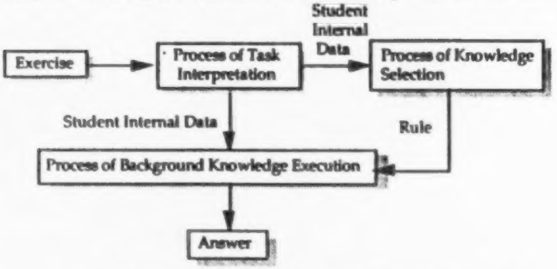

Exercise
Process of Task Interpretation
Student Internal Data
Process of Knowledge Selection
Student Internal Data
Rule
Process of Background Knowledge Execution
Answer

Figure 4 Relationship between sub-processes.

1) Process of Task Interpretation

This subprocess involves the selection of the appropriate knowledge needed to solve the given problem. The knowledge selected by the student is called his/her internal data.

2) Process of Background Knowledge Selection

Based on the student's internal data, this subprocess involves the searching of the appropriate problem solving process. We assume that these processes are represented as production rules in his/her internal data. This subprocess can thus be seen as the matching of the conditions of all production rules against the student's internal data obtained in the previous subprocess.

3) Process of Background Knowledge Execution

This involves the application of the actions of the selected production rules to the student's internal data, therefore producing a solution to the given problem.

4.2 An Example of the Problem Solving Process

An example of the problem solving process described in subsection (4.1) can be seen in figure 5. This example requires the student to transform an English sentence into a potential form by using the expression 'to be able to'.

Exercise : Transform this sentence into a potential statement by using the expression ' be able to'
Sentence : He read an English book.

Process of Task Interpretation
Student Internal Data:
(Sentence : He read an English book.)
(Goal of Transformation : Transform sentence into a potential form by using the expression 'to be able to')
(Verb : read) (Subject : he) (person of the Subject : The Third Person Singular) (Tense : Past)

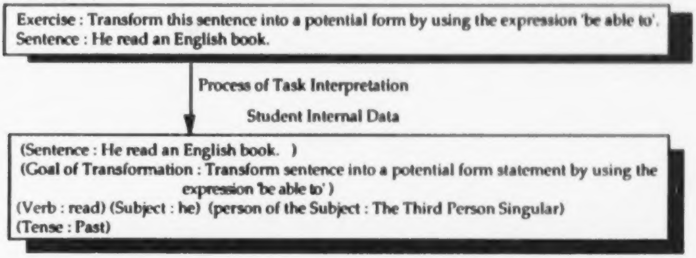
Process of Background Knowledge Selection
Rule : If (Goal of Transformation = potential form by using the expression 'be able to')
(person of the Subject = The Third Person Singular)
(Tense = Past)
Then (Insert 'be able to' in front of the Subject)
(Transform The verb into original form)
(Transform 'be' into 'was')

Process of backgroung Knowledge Execution
Answer : He was able to read an English book.

Figure 5 An Example of Problem Solving Process.

4.3 Analysis of mistakes during the problem solving process

We shall analysis the possible mistakes in each of the subprocesses described in subsection (4.1).



Exercise : Transform this sentence into a potential form by using the expression 'be able to'.
Sentence : He read an English book.

(Sentence : He read an English book.)
(Goal of Transformation : Transform sentence into a potential form statement by using the expression 'be able to')
(Verb : read) (Subject : he) (person of the Subject : The Third Person Singular)
(Tense : Past)

Figure 6 The selection of an inappropriate of answer.

4.3.1 Process of Task Interpretation

By providing the inappropriate answer, the student may induce the accumulation of incorrect internal data. This error may occur because of two reasons :

1) The selection of an inappropriate piece of knowledge, and

2) The lack of recognition that a certain piece of knowledge applies to the

problem.

Figure 6 shows an example of 1) above. In the case shown, the student has inappropriately selected the tense as 'present tense'. By generating this internal data, the wrong rules will be selected during the knowledge searching subprocess.

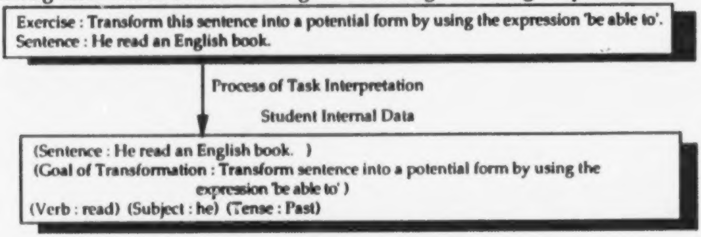

Exercise : Transform this sentence into a potential form by using the expression 'be able to'.
Sentence : He read an English book.
Process of Task Interpretation
Student Internal Data
(Sentence : He read an English book.)
(Goal of Transformation : Transform sentence into a potential form by using the expression 'be able to')
(Verb : read) (Subject : he) (Tense : Past)

Figure 7 The lack of recognition.

Figure 7. shows an example of 2) above. In this example the student fails to realize that the number and person of the subject bears relation to the problem. By generating internal data that lacks this information, rules that do not apply to the problem may also be selected.

4.3.2 Process of Background Knowledge Selection

Even assuming the student's internal data to be correct, if the correct rules are not selected during this subprocess, the student will not be able to find the correct solution to the problem. There are two possible types of mistakes in this subprocess. Figure 8 gives a specific example of both.

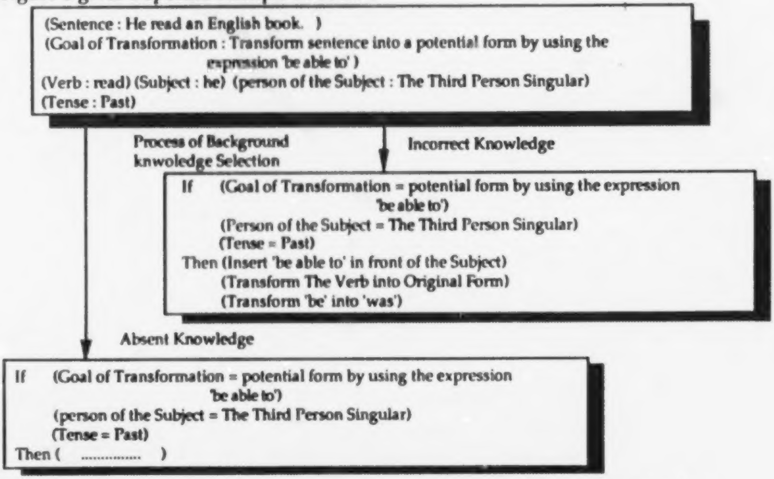

(Sentence : He read an English book.)
(Goal of Transformation : Transform sentence into a potential form by using the expression 'be able to')
(Verb : read) (Subject : he) (person of the Subject : The Third Person Singular)
(Tense : Past)
Process of Background knwoledge Selection
Incorrect Knowledge
If (Goal of Transformation = potential form by using the expression 'be able to')
(Person of the Subject = The Third Person Singular)
(Tense = Past)
Then (Insert 'be able to' in front of the Subject)
(Transform The Verb into Original Form)
(Transform 'be' into 'was')
Absent Knowledge
If (Goal of Transformation = potential form by using the expression 'be able to')
(person of the Subject = The Third Person Singular)
(Tense = Past)
Then (...............)

Figure 8 Mistakes in the subprocess of Background knowledge Selection.

1) Incorrect Hypothetical Knowledge

In the example shown in figure 8, the student incorrectly answered that to produce a potential form with the expression 'to be able to', the verb 'to be' should remain in its infinitive 'be' form rather than the tense of the original sentence. His/her knowledge of potential forms is therefore incorrectly stabilized. We Believe that even if the student generated the correct internal data, the application of such a rule as described above will always generate an incorrect response. Also, it can be seen that the student's 'incorrectness' is regular and predictable.

2) Absent Knowledge

When the student's knowledge is not sufficient to solve a given problem and he/she knows this fact, he/she may try to apply a different rule in order to solve the problem. In this case, the incorrect answer is completely ad hoc and no regularity exists.

4.3.3 Process of Background Knowledge Execution

Even supposing that the first two subprocesses yielded the correct rules, the student may still arrive at the wrong response by applying the rules incorrectly. This will happen if the student's mastery of any given rule is not adequate.

4.4 Stability Model

The authors have analyzed the student's learning process and have proposed a 3-level knowledge stability model in a previous paper[4][5]. The domain knowledge of the system which was described is English Vocabulary and the 3 levels proposed were in that case quite adequate.

However, as shown in section 3, the problem solving processes involved in the system here described are comparatively more complex. We shall now deal with the knowledge stability model for this system.

4.4.1 Characteristics of mistakes when grouped by similarity

The type of mistakes identified in the previous subsections can be grouped according to their similarities. By analyzing theses groups, the following 4 knowledge state can be selected :

1) Correct stable knowledge,
2) Absent knowledge,
3) Incorrect stable knowledge,
4) Unstable correct knowledge.

In this paper, we have dubbed these as :

1) Stable Knowledge,
2) Absent Knowledge,
3) Incorrect Hypothetical Knowledge,
4) Correct hypothetical Knowledge.

Figure 9 shows the relationship between these 4 states.

5 CONSTRUCTION OF A STUDENT MODEL BASED ON KNOWLEDGE STABILITY

In this section we shall describe the Student Model we have incorporated in this system. As with the Domain Knowledge Base, the Situation Memory is also divided into global and local structures.

5.1 The global structure

The global structure utilizes an overlay model based on the network describing the inheritance relationships between the different problem solving knowledge. This model represents the state of the student's grasp of each section. The system chooses which section to reach based on this model.

If the student cannot provide the correct responses, the system provides the tutoring necessary.

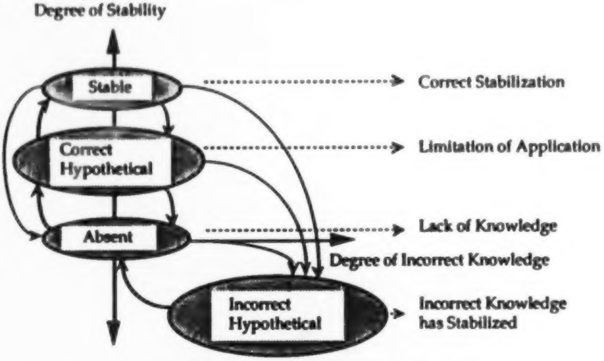

Degree of Stability
Stable
Correct Hypothetical
Absent
Incorrect Hypothetical
Correct Stabilization
Limitation of Application
Lack of Knowledge
Degree of Incorrect Knowledge
Incorrect Knowledge has Stabilized

Figure 9 Knowledge Stability Model.

5.2 The local structure

Two status must be represented in the local structure :

1) The state of each individual problem solving knowledge,

2) Parts within a section that can yield a response.

In this system, 1) and 2) above are represented by a knowledge stability model and an overlay model respectively.

The knowledge stability model represents one of the four levels described in the previous section. The system determines what problems should be proposed to the student by looking at this model. The overlay model is used to represent only correct hypothetical knowledge. This model classifies each section's problems according to their relative difficulty and creates a template to be used. The region of the student's problem solving knowledge that can be used to arrive at a response can be represented as a subset of the set of all problems. This model is used to ensure that the system selects problems that will yield the highest knowledge stability level.

6 STUDENT'S STATE DIAGNOSIS STRATEGY

6.1 Global strategy

When a student gives an incorrect response to a given exercise, the system must seek the cause of the mistake. However, it is impossible to ascertain whether it has been inherited to the section being drilled or whether it has been inherited from a lower section. Therefore, in order to determine the problem, the system questions the student directly.

6.2 Local strategy

After globally determining the section actually responsible for a certain mistake, the system must classify it in as much detail as necessary to help determine the appropriate teaching strategy. Based on this finer diagnosis, the knowledge stability level is assigned. If it is diagnosed to be a correct hypothetical knowledge, the subject of response-yielding problems is selected based on the relative difficulty of the problems.

7 MISTAKES AND TEACHING STRATEGIES

7.1 Correct Hypothetical Knowledge

When this sort of problem is diagnosed, the system extracts a selection of problems that will yield a correct response from the student. The objective of the tutoring of knowledge in this state is to enlarge this subset, and simultaneously to enhance the stability level towards the prerequisite level. Therefore, the strategy used in this case is to select the most appropriate problem which is believed to be able to expand the existing subset.

7.2 Absent Knowledge

7.2.1 Unrecognized knowledge (Problem Understanding Subprocess)

In order to make the student understand that the specific piece of knowledge he/she failed to recognize is relevant to the problem at hand, the system directly questions the student about it. If the student is able to answer the question correctly, a simple exercise problem is chosen and the system internally generates a response. It then explains to the student how the lack of recognition of that piece of knowledge is related to the response. It also shows the student the correct answer. If the answer to the question is incorrect, the system simply teaches the appropriate response directly.

7.2.2 Absent Knowledge (Knowledge Searching Subprocess)

When the student realizes that he/she does not have the necessary knowledge in order to solve a given problem, he/she tries to fill the gap by selecting a different rule that he/she believes to be adequate. In this case, the system must teach the correct answer directly. When tutoring the system uses a simple example in order to help the student's understanding. The system also checks the student's understanding by proposing a simple practice problem.

7.3 Tutoring Strategies for Incorrect Hypothetical Knowledge

7.3.1 Unrecognized knowledge (Understanding Subprocess)

When knowledge of sentence characteristics is inappropriate, the student must be made aware of it. This is done by comparing the incorrect answer with the correct one.

7.3.2 Incorrect Stable Knowledge (knowledge Searching Subprocess)

The incorrect rule is selected and applied to a simple sample problem generating an incorrect response which is then shown to the student along with the correct response. After this, the student is taught the correct rule explicitly.

7.4 Stable Knowledge

Correct Stable Knowledge doesn't need to be taught to the student. However, once a certain piece of knowledge has been stabilized, it must be practiced once in a while to ensure that the student's mastery of it does not decrease. Thus, problems requiring the application of correct Stable Knowledge are sometimes proposed.

8 CONCLUSION

This paper has proposed the construction of a student model that allows the system to see students' mistakes from a cognitive standpoint. This model allows the representation of knowledge stability levels.

We have also describes teaching strategies that may be used in connection with this student model.

We have divided the stability levels into 4 groups : Incorrect hypothetical knowledge, Absent knowledge, Correct hypothetical knowledge and Prerequisite knowledge. We have assumed that, after the student's knowledge has stabilized, it does not change.

We believe that further research must be carried out to improve the model here described to allow changes in stability after knowledge stabilization. It would reflect real classroom situation better in this way.

This system has been implemented in a Macintosh using the Allegro Common Lisp.

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